Robyn Stuber
W-5-1
EFFLUENT CHEMISTRY
BIOASSAY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

October 19, 1993

Steven L. Costa
Project Manager
CH2M Hill
P.O. Box 12681
Oakland, CA 94604-2681

Re: Approval of Modifications to the Joint Cannery Outfall Study Plans: Effluent Chemistry and Bioassays

Dear Steve:

We have reviewed the reports on the chemical analysis of effluent for VCS Samoa Packing (April 30, 1993) and StarKist Samoa (April 29, 1993), as well as the technical memorandum of May 10, 1993 on bioassay tests on the combined cannery effluent. Our comments on these reports and their recommendations are as follows:

Effluent Bioassay Tests

The first bioassay results indicated the effluent probably has a high immediate dissolved oxygen demand (IDOD) which was responsible for the observed mortality of the test organisms. We approve of the proposal to continue to use a combined cannery effluent sample as done in the first bioassay tests, and include immediate dissolved oxygen demand (IDOD) tests on these samples. The tests will then be run with sufficient aeration to support the test organisms. Parallel tests should also be run following standard procedures.

Reasonable attempts must be made to obtain *Penaeus vannamei* as the test organism. However, in the event these organisms are not available, *Mysidopsis bahia* and/or *Holmesimysis costata* may be used as substitute organisms.

Please see the attached memo from Amy Wagner of EPA's Laboratory Support Section for further comments on the results and proposed study plan.

Chemical Analysis of Effluent

The chemical analysis of the effluent revealed exceedances of ambient water quality standards for silver (StarKist) and copper and zinc (Samoa Packing). If the results of the second tests show similar exceedances, this will be cause for concern and we will require the canneries to seek the source of the metals and implement measures to reduce their discharge.

However, since dioxin and asbestos were not detected in the effluent, we are approving the request to eliminate analyses for these substances in future effluent chemical analyses.

Please call Pat Young at 415/744-1594 if you have any questions regarding the above.

Sincerely,

for Norman L. Lovelace, Chief
Office of Pacific Island and Native
American Programs (E-4)

Enclosure

cc: Jim Cox, Van Camp Seafood Company
Norman Wei, StarKist Seafood Company
Tony Tausaga, American Samoa EPA
Sheila Wiegman, American Samoa EPA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

October 1, 1993

SUBJECT: Review of Joint Cannery Outfall Effluent Bioassay Testing results

FROM: Amy L. Wagner, P-3-1
Laboratory Support Section

THRU: Brenda Bettencourt, Chief
Laboratory Support Section

TO: Pat Young, E-4
OPINAP

I have reviewed the bioassay testing report of the Joint Cannery Outfall for StarKist Samoa and VCS Samoa Packing. The comments below summarize our discussion today.

1. The report suggests (p. 4) that a high immediate dissolved oxygen demand (IDOD) may be responsible for the toxicity testing results. However, supplementary tests still showed 100% toxicity when test containers were aerated. These results suggest toxicity in the effluent was due to factors other than low dissolved oxygen concentrations. It should be noted that the chemical analyses indicated high levels of metals. Specifically, the reported values for copper and zinc exceed some acute levels for marine invertebrates in the water quality criteria documents.

2. The manual "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms," Fourth Edition, EPA/600/4-90/027, should be followed more closely in future tests. As stated in Table 15 (p. 64), aeration should be provided if dissolved oxygen falls below 4.0 mg/L and a renewal of the test solutions must be conducted after 48 hours. As proposed in the report, an IDOD test may be run on the effluent prior to testing.

3. Although testing is being conducted on a semi-annual basis, a reference toxicity test must also be run concurrently with the effluent toxicity test. Reference toxicity tests are stipulated in the acute toxicity testing manual (p.8) and provide information on the consistent quality of test organisms.

4. Use of the white shrimp, Penaeus vannamei should be continued. If this species is unavailable, Mysidopsis bahia would be an acceptable surrogate species since it is listed in EPA's acute toxicity testing methods manual to be mandated in the Federal

Register this year. Formal approval of this substitute organism is the responsibility of the Permits Issuance Section.

Further information regarding toxicity testing policy and permit language should be referred to the Whole Effluent Toxicity Coordinator, Debra Denton (W-7-1), at 744-1919. I have given her a copy of the permit and report. If you have any further questions, please do not hesitate to contact me at 744-1495.

cc: Debra Denton, W-7-1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

MAY 0 1 1996

Barry A. Mills
General Manager
StarKist Samoa, Inc.
P.O. Box 368
Pago Pago, American Samoa 96799

Re: StarKist SPCC Plan

Dear Mr. Mills:

This letter is in regards to StarKist Samoa, Inc.'s Spill Prevention, Control and Countermeasure (SPCC) Plan, revised February, 1996. We have completed our review of the revised SPCC Plan. Based on our review of the revised SPCC Plan it is in apparent conformance with SPCC regulations (40 CFR Part 112) pertaining to the prevention oil from reaching waters of the United States.

We have no further comments regarding the revised SPCC Plan and appreciate StarKist Samoa, Inc.'s efforts in addressing our concerns to bring the SPCC Plan into conformance with SPCC regulations. StarKist Samoa, Inc., should be fully implementing the SPCC Plan at this time. We will be following up on the implementation and conformance of the facility with the SPCC Plan during regularly scheduled inspections of the StarKist Samoa, Inc., cannery.

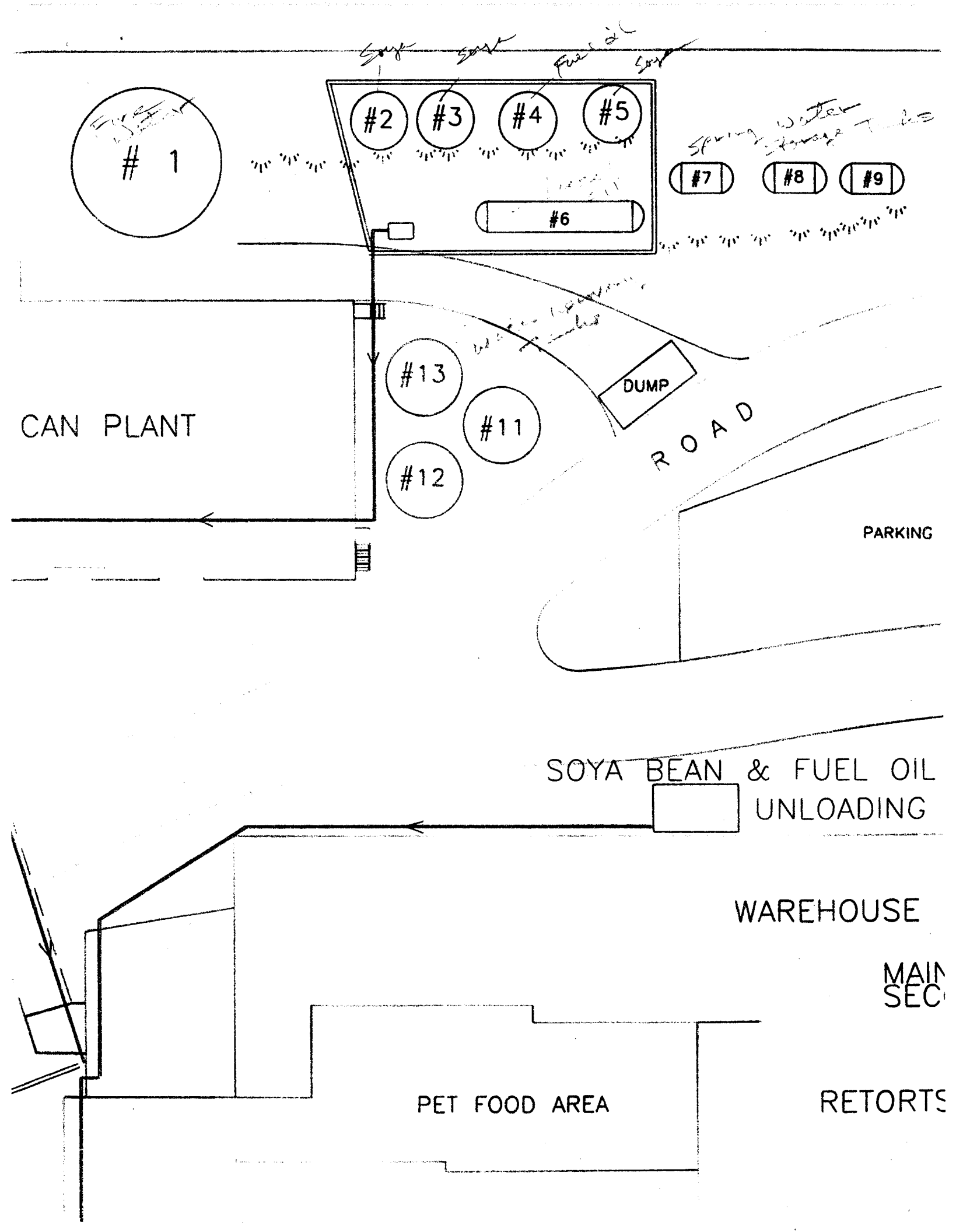
If you have any questions regarding this matter, please contact Mike Lee at (415) 744-1592 or Pat Young at (415) 744-1594.

Sincerely,

Norman L. Lovelace, Chief
Office of Pacific Island Programs

cc: N. Wei, StarKist Foods, Inc.
T. Tausaga, ASEPA
S. Wiegman, ASEPA

TANK #	CONTAIN	CAPACITY
1	FIRE WATER	365.000
2	SOYA BEAN OIL	42.300
3	SOYA BEAN OIL	42.300
4	I.F.O. # 5 FUEL OIL	42.300
5	SOYA BEAN OIL	42.300
6	DIESEL OIL # 2	7.500
7	SPRING WATER	4.400
8	SPRING WATER	4.400
9	SPRING WATER	4.400
11	POTABLE WATER	87.500
12	WATER RECOVERY	39.700
13	WATER RECOVERY	39.700
14	WASTE INFLUENT	200.000
15	HIGH STRENGTH	200.000
16	D.A.F. EFFLUENT	60.000
17	THAW WATER STORAGE	86.000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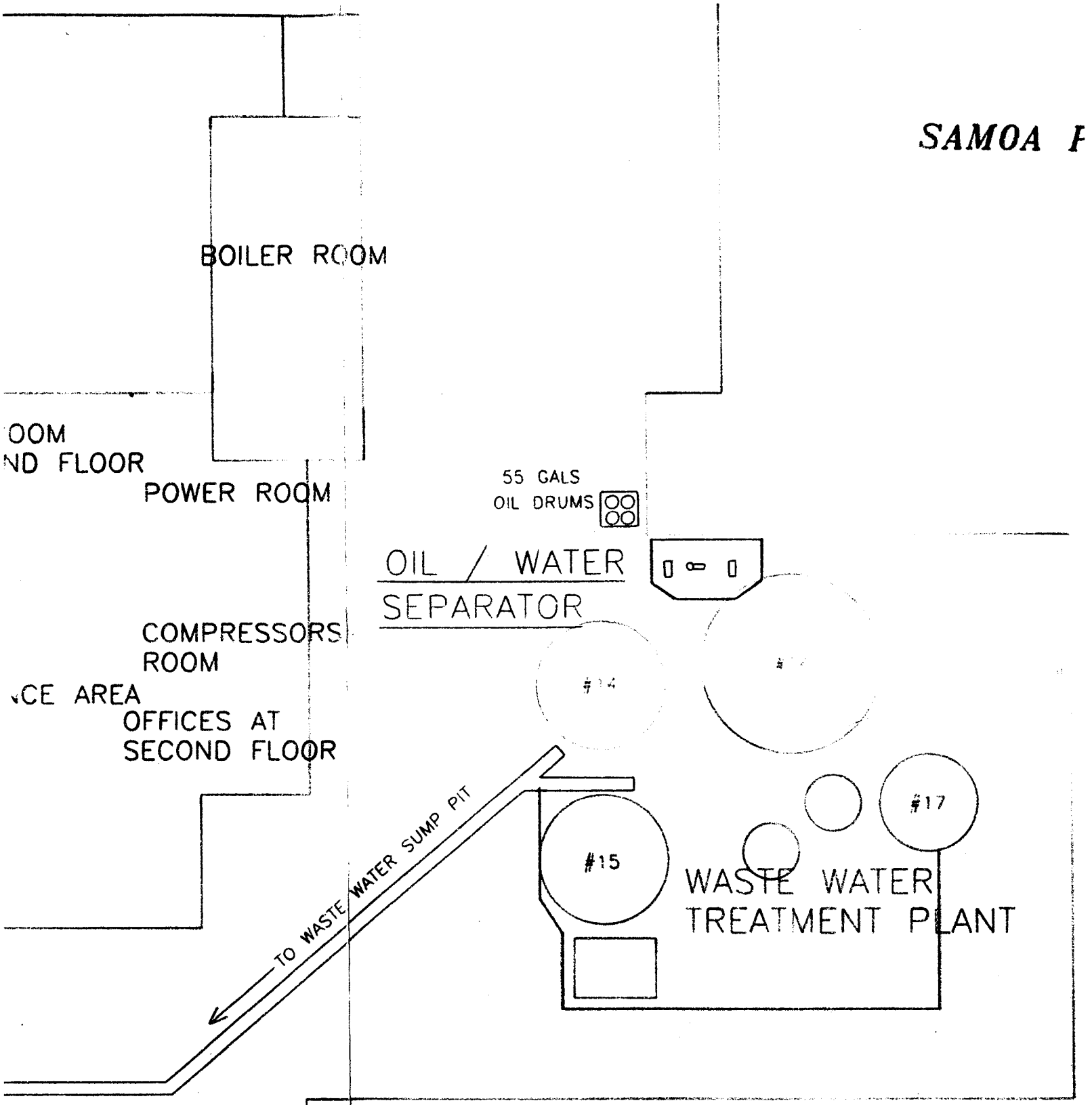
PARKING
SOYA BEAN & FUEL OIL
UNLOADING
WAREHOUSE
PET FOOD AREA
RETORTS

SAMOA F



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STARKIST SAM

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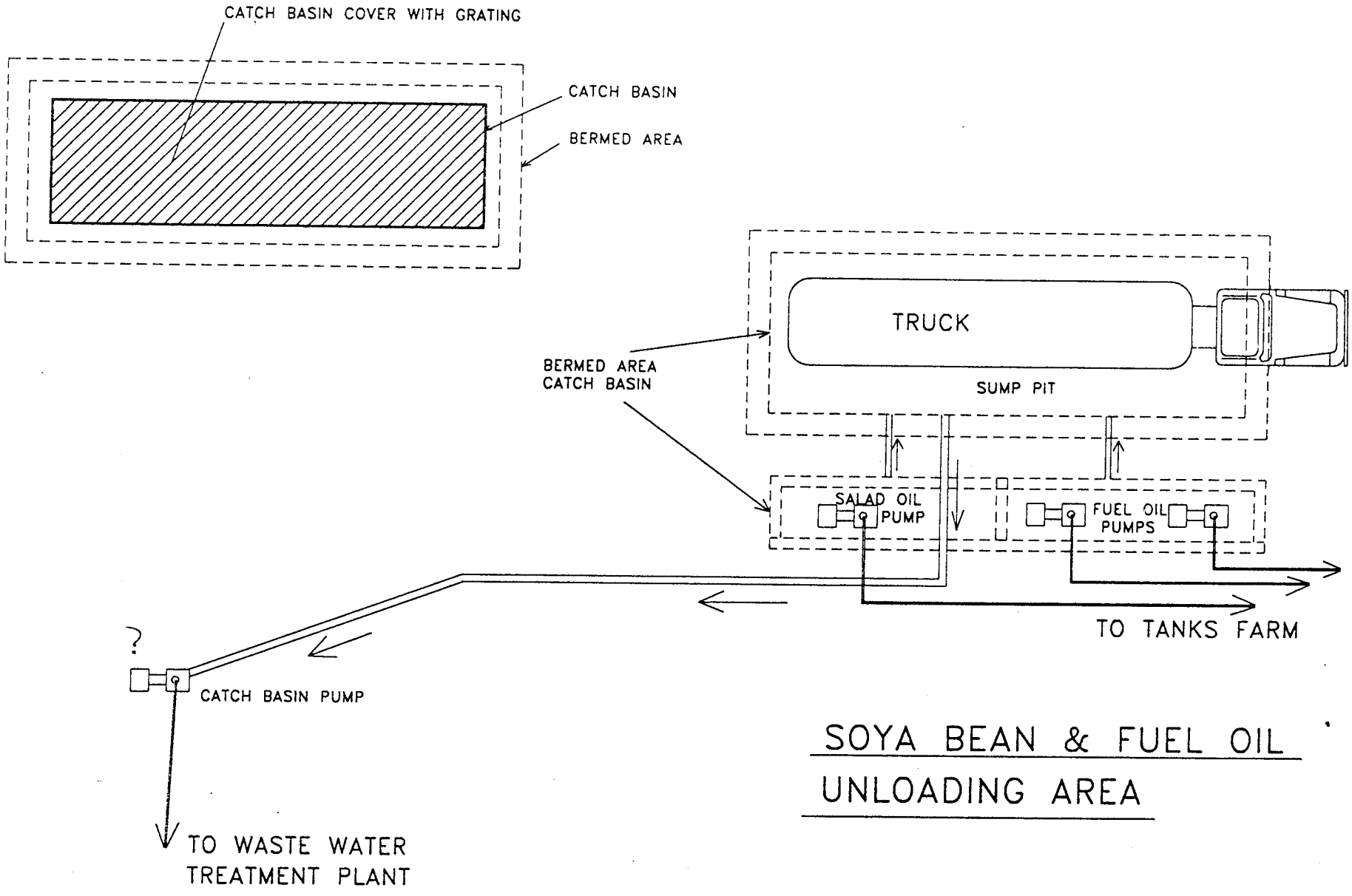
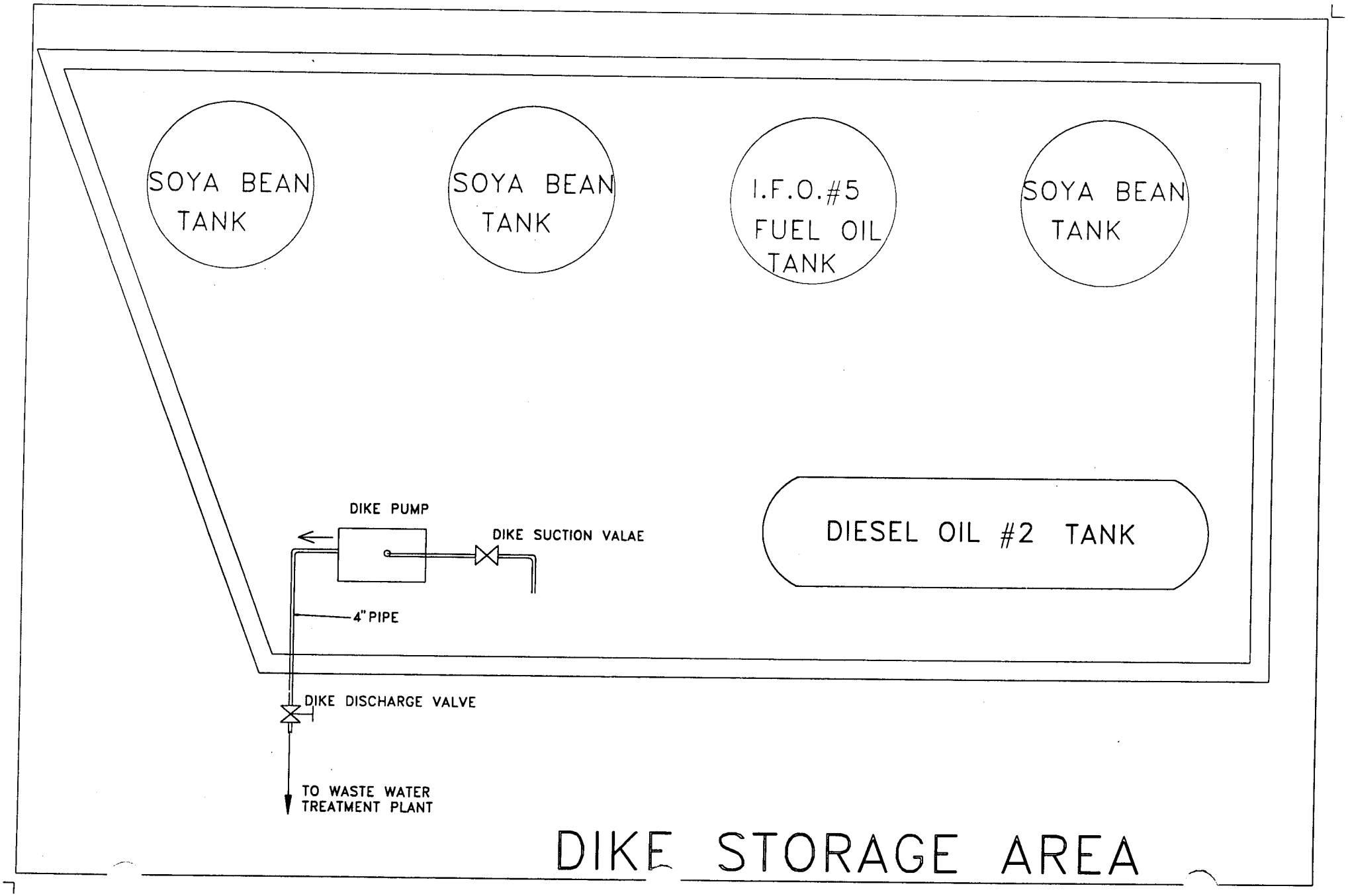


SOYA BEAN & FUEL OIL UNLOADING AREA



DIKE STORAGE AREA

Rec'd EPA 2/19/98 CG
Copy to Amer Oda

gdc

COASTAL ENVIRONMENTAL ANALYSTS

12 February 1998

Terry Oda
U.S. Environmental Protection - Region 9
75 Hawthorne Street
San Francisco, CA 94105

Dear Terry,

Re: Proposed Ocean Dumping Permit for COS Samoa Packing
Request for Higher Limits for Total Solids and Total Volatile Solids

I am sending this correspondence on behalf of COS Samoa Packing. I have been involved with a number of the studies required under the existing ocean dumping permits for the tuna canneries in American Samoa as a consultant to Samoa Packing. I am familiar with the activities and permit requirements involved and have reviewed the proposed draft permits.

When the application for renewal of the existing permit was submitted, all available monitoring data were included. The proposed new permit limits were based on these data. Since the application was submitted additional monitoring data have been collected and submitted to EPA.

Based on the data submitted, the draft permit reduces the limit for total solids from 54,590 mg/l to 43,170 mg/l and reduces the limit for total volatile solids from 58,760 mg/l to 38,320 mg/l. These reductions were based on the data available throughout the period of the existing permit to the time the permit renewal application was submitted. However, more recent data, generally the last half of 1997, show higher concentrations that are more consistent with the previous limits. A summary of all available data (September 1993 through November 1997) was sent to Carl Goldstein, American Samoa Program Manager for EPA in a letter from Jim Cox on January 6, 1998 requesting a review and increase of the proposed limits.

The nature of the high strength waste, composed of a number of individual waste streams from the cannery, results in substantial and unavoidable variability from day-to-day. A summary of the statistics describing the data set is shown in the table below. In the table below I have also shown the results of the "reasonable potential calculations" based on EPA's method in the TSD for Water Quality-based Toxics Control. However, the extreme variability found in the data probably argues against application of this methodology - the results are included simply for illustration. I suggest consideration of applying a limit based on your examination of the data set and using some measure such as the mean plus two standard deviations.

COS Samoa Packing would appreciate your review of the data and requests that the proposed draft limits for these two constituents be revised upward to avoid the potential of permit violations. The ocean dumping studies performed jointly for Samoa Packing and StarKist Samoa clearly indicate that such an adjustment would not lead to an increased potential for environmental degradation in the waters surrounding the designated dumping zone. As an major participant in conducting the special studies (bioassay and dilution modeling) for the existing permit, I am familiar with the site and the

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PHONE: 707-826-0717 or 7662 • FAX: 707-822-0567
EMAIL: GLATZELDACOSTA@SPRINTMAIL.COM

study results. In my judgment, even within the permitted dumping zone, any changes in water quality resulting from higher limits would be negligible and probably unmeasurable.

Thank you for your time and consideration of this matter. Please call me directly, or contact Jim Cox at Chicken of the Sea International, if you have any questions or require additional information.

Sincerely,

Steven L. Costa, Ph.D.

cc: Jim Cox, Chicken of the Sea International
Carl Goldstein, EPA Region 9, American Samoa Program Manager
David Wilson, CH2M HILL/SEA
Karin Noack, CH2M HILL/SFO

Total Solids and Total Volatile Solids Concentrations (mg/l)
COS Samoa Packing
September 1993 - November 1997

Statistic	Total Solids	Total Volatile Solids
Minimum	5,390	897
Maximum	86,900	72,800
Mean	27,205	17,847
Standard Deviation (SD)	19,616	16,821
CV	0.72	0.96
Mean + 2(SD)	66,437	51,128
Reasonable Potential at 99% CL, 95% Probability [1]	95,600	80,100
Reasonable Potential at 99% CL, 99% Probability [1]	139,000	131,000

[1] Calculations based on method given in the "Technical Support Document for Water Quality-based Toxics Control", EPA, 1991.

MIKE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 9
75 Hawthorne Street
San Francisco, CA 94105-3901

February 26, 1998

Mr. Barry Mills
General Manager
StarKist Samoa, Inc.
P.O. Box 368
Pago Pago, American Samoa 96799

RE: NPDES Permit Renewal
NPDES Permit AS0000019

Dear Mr. Mills:

By way of this letter, we are administratively extending your permit until new ones are issued. All permit requirements and limitations shall stay the same during this interim period with the exception of the ambient monitoring plan. As discussed in more detail below, we are proposing to revise your ambient monitoring program with the goal of better gauging water quality throughout Pago Pago harbor while not increasing the canneries' current level of effort.

Monitoring data collected by the canneries has shown marked improvement in water clarity in inner Pago Pago harbor. This improvement is due undoubtedly to the relocation of the canneries outfall. However, though the clarity of the water in Pago Pago has improved, water quality problems still exist and remain a concern. Various harbor monitoring studies have indicated the presence of heavy metals in the water column (lead, copper and zinc), sediments (lead, mercury, copper, zinc, tributyltin) and fish tissue (chromium, arsenic, lead, mercury, and PCBs). In addition, there still exists a fish advisory warning residents not to eat fish caught in the Harbor.

Although the various monitoring studies have been informative, the monitoring data is sparse, and the source(s) of these pollutants remains unclear. Without a more comprehensive knowledge of conditions in the harbor, it will be difficult to gauge changes in water quality over time, and make informed decisions to protect the public health. Also, without knowing background concentrations of metals, it will be very difficult to determine the dilution necessary for the canneries' discharges to meet water quality standards for certain pollutants (i.e., copper and zinc).

We and ASEPA are soliciting the views and participation of all parties who are or will be affected by or are interested in water pollution control in American Samoa (i.e. Tuna Canneries, Southwest Marine, ASG, ASPA, public). To that end, we hope the canneries will be receptive to playing a more comprehensive role in monitoring Pago Pago harbor. Changes in the canneries' ambient monitoring program would be made in exchange for certain existing monitoring requirements. Therefore, the canneries monitoring effort should not increase, and may decrease.

We hope the canneries will participate us, and ASEPA, in the design of the harbor-wide monitoring program.

As a preliminary step to designing the new receiving water monitoring program, we are currently compiling all data that exists regarding Pago Pago harbor.

Thank you in advance for your anticipated participation in this process. If you have any questions, please contact Carl Goldstein of my staff at (415) 744-2170.

Sincerely,

Norm Lovelace, Manager
Pacific Insular Area Programs

cc: ASEPA
Doug Liden, EPA Region 9

StarKist Samoa, Inc.

A Subsidiary of Star-Kist Foods, Inc.

P.O. Box 368
Pago Pago, Tutuila Island
American Samoa 96799

Telephone: 684 644-4231
Facsimile: 684 644-2440

April 6, 1995

Norman L. Lovelace
Chief, Office of Pacific Island and
Native American Program
U. S. EPA Region 9
75 Hawthorne Street
San Francisco, CA 94105

Re: NPDES Inspection Report

Dear Mr. Lovelace:

This letter is written in response to your letter of February 24, 1995 which we received on March 6, 1995. I have discussed the subject matter with my staff here in American Samoa and Norman Wei of our Corporate Office in Newport, Kentucky. The following are our responses to your information request:

Fishmeal Plant Improvement. The $6 million planned improvement and expansion for the fishmeal plant has been revised in light of recent changes in corporate business plans. On September 6th, 1994, StarKist announced the closure of its can manufacturing facility at the Tafuna Industrial Park. In the same announcement, our corporate office also stated that a "major new capital investment in the operation at Atu'u contemplated earlier was unlikely due to declining tuna consumption in the U. S., the impact of foreign competition, and cost disadvantages associated with processing tuna in Samoa".

A fishmeal equipment contractor will be visiting our facility this month to recommend improvements in manufacturing process, oil recovery and odor control. Since the submission of the first report to EPA on the fishmeal plant, StarKist Samoa has spent over $300,000 in equipment refurbishment and safety related matters.

Fishing Vessel Education. All fishing vessel personnel are routinely advised and admonished by our Fish Coordination Department not to throw refuse into the harbor.

Have a hard copy?

Prior to unloading of merchandise from the vessels, they are inspected for presence of refuse in plastic bags as evidence that such refuse has not been discarded overboard.

Bilge Water Collection. Arrangement has been made with a local contractor (Harbor Refuse & Environmental Services) to collect bilge water from the fishing vessels. This arrangement was made in fulfillment of the U. S. Coast Guards' requirement for a Certificate of Adequacy under the Oil Pollution Act.

Heavy Metals Evaluation/Follow-up. The latest Priority Pollutants scan of StarKist Samoa's effluent was conducted in October 1994. The laboratory results showed zinc concentrations in the effluent to be below the EPA water quality criterion level. Concentrations of silver in both the February/October 1994 scans were below detection levels.

Spill Prevention Control and Countermeasure Plan. The SPCC is in the process of being updated and will be submitted to your agency for review as soon as it is completed. StarKist Samoa has recently completed a Facility Response Plan for unloading activities at the Public Dock where two 40,000-gallon vegetable oil storage tanks are located. This Plan received the U. S. Coast Guards' approval two weeks ago and will be incorporated by reference in StarKist's SPCC. It is anticipated that the overall SPCC will be submitted to the agencies for approval no later than April 28, 1995.

We greatly appreciate the opportunity to respond to the inspection report. We are committed to working with your agency and the American Samoa Government to resolve any environmental issues that may affect our operation on the island.

Any questions, please do not hesitate to contact me.

Sincerely,

STARKIST SAMOA, INC.

BARRY A. MILLS
General Manager

cc: S. Wiegman, American Samoa EPA
T. Tausaga, American Samoa EPA
N. Wei, StarKist Foods, Inc.
V. Shouse, StarKist Samoa, Inc.

StarKist Samoa, Inc.

A Subsidiary of Star-Kist Foods, Inc.

P.O. Box 368
Pago Pago, Tutuila Island
American Samoa 96799

Telephone: 684 644-4231
Facsimile: 684 644-2440

October 13, 1993

TO : Norman Lovelace, US EPA Region IX
Togipa Tausaga, ASG EPA

FROM : Maurice W. Callaghan

SUBJECT: POLLUTION PREVENTION PROGRAM

==========

Please find attached a copy of StarKist Samoa, Inc.'s Pollution Prevention Program in partial fulfillment of our NPDES requirements.

Please call me or Norman Wei if you have any questions.

/tl

cc: B. Mills
W. Adams
N. Wei
R. Ward

Pollution Prevention Program

Introduction

In 1992, StarKist Samoa Inc. initiated a comprehensive Pollution Prevention Program. This report is submitted in fulfillment of the requirements of the company's NPDES permit.

Source Reduction and Waste Minimization Programs

The following sections describe the various components of StarKist Samoa's source reduction and waste minimization programs.

Replacement of Existing Fishmeal Plant. A major component of the source reduction program is StarKist Samoa's plan for a new fishmeal plant. The plant has received corporate approval to replace the entire fishmeal plant at a cost in excess of $6.5 million. StarKist Samoa is now in the final stage of negotiation with the contractor to initiate construction of the plant. Projected installation time is estimated to be 15 months. The new fishmeal plant will include a centrifuge and a multi-stage distillation unit which would recover oil and protein from the cooker juice and press liquor - the two high strength waste streams which are presently being disposed of at an EPA designated dump site. The new fishmeal plant will also have an odor control system. This $6.5 million fishmeal plant is the corner stone of StarKist Samoa's source reduction program.

Over the past three years, StarKist Samoa has spent over $400,000 on refurbishing equipment at the fishmeal plant.

Stormwater Prevention Plan. In March of 1993, StarKist Samoa submitted its Storm Water Pollution Prevention Plan to the US EPA and AS EPA in compliance with its General Storm Water Permit.

As part of its Best Management Practices, StarKist Samoa initiated stormwater improvement projects in excess of $400,000 to eliminate storm drains and runoffs and greatly minimize the commingling of process water and stormwater.

Specifically, the following tasks have been completed as of October 7, 1993:

1. Eight unused outfall pipes were sealed with concrete to ensure no process water can inadvertently be discharged into the harbor.

2. The Boiler Room is bunded and a catchment grating installed to direct all wash down water to the Wastewater Treatment Plant. This ensures that no process water will escape to the alley.

3. A bund was installed around the can wash pit to ensure any overflow will stay inside the pit.

4. The drain from the Busse Unloader area was diverted from the storm water system to the Wastewater Treatment Plant inside the Packing Room.

5. The storm water grate in alley #2 adjacent to the fish meal plant was diverted to the Packing Room wastewater sump. It was sealed and isolated from the storm water system.

6. The grated storm water inlet next to the waste water treatment tanks was relocated approximately 45 feet further up-slope in the alley. This eliminated any possibility that process water from the Wastewater Treatment tank area or the Compressor Room could drain into the storm drainage system.

7. The storm drain inlet located at the end of the alley between Freezer #2 and #3 has been reconstructed to exclude any dock washdown water.

8. The gap in the foundation at the back of the Fish Meal Plant has been filled in with concrete to prevent washdown water from escaping and entering the storm drain system.

9. All storm drain covers in areas where there are fish processing have been sealed off.

10. A new 140 feet by 8 feet concrete access road at the West end of the Can Plant was installed to ensure no oil or hazardous wastes will get into the storm water system from accidental spills.

11. All storm water down spouts have been sealed to ensure no process water can enter the storm drainage system

12. Approximately 50 percent of the 600 feet of four inch PVC pipe connecting the fuel tank bund to the Wastewater treatment system in the Packing Room have been installed.

13. The section of the dock where the old salt water pumps were located is covered with a steel plate at present. The steel plate is not sufficiently watertight to insure wash down water cannot leak into the harbor . This opening will be filled with concrete to become a permanent part of the dock .

Essentially most of the capital improvement projects have been completed. The only remaining item to be completed is the replacement of the existing diesel tank and paving of the bunded area. Any contaminated soil in the bunded area will be removed or remediated. The estimated time frame for completion is 6 months.

One major area of concern to StarKist Samoa is the overflow of contaminated stormwater from the truck loading area east of StarKist's property through the public right-of-way to StarKist's wastewater treatment plant. This problem has been brought to the attention of the US EPA and AS EPA.

Waste Oil Recycling. In order to minimize the input of diesel and motor oil into its waste streams, StarKist Samoa has been for some time burning its waste oil in its boilers. Arrangements have also been made with the American Samoa Power Authority to incinerate some of StarKist Samoa's waste oil.

Water Conservation Program. StarKist Samoa implemented its water conservation program approximately two years ago. This program consists of:

1. Installation of flow reduction devices such as water spray guns on water hoses.

2. Increased dry sweeping of the packing room floors prior to wet cleaning.

3. Use of reclaimed retort water as boiler feed water.

4. Installation of individual water meters in over 14 work areas such as the packing room, fishmeal room, dock area, can wash area, etc. to better track water usages throughout the plant.

5. Formation of a Quality Improvement Team under StarKist's Total Quality Management Program to track water usages throughout the plant.

The cumulative result of these efforts is a water usage reduction of approximately 10 percent. The Table below shows typical results for a four week period since installation of the water guns.

Week of Jan 03, 1993	4,942,060 gallons
Week of Jan 10, 1993	4,908,150 gallons
Week of Jan 17, 1993	4,854,690 gallons
Week of Jan 24, 1993	4,492,140 gallons

Bilge Water Program. StarKist Samoa is making arrangement with Southwest Marine to collect and treat the bilge water of fishing vessels docked at its facility.

Training of Personnel in Safety and Environmental Issues. StarKist Samoa began implementation of the following training programs:

The Honolulu firm of Environmental Technologies International (ETI) was retained by StarKist Samoa to conduct comprehensive environmental and safety training on-site. The cost was in excess of $ 25,000. As of June 1993, 16 employees have received 24-hour emergency response

training, 15 employees on responsibilities of large quantity generators, 15 on hazardous waste site cleanup, and 14 on safe transportation of hazardous materials.

An emergency evacuation plan was also prepared by ETI for the entire cannery at a cost of $10,000.

The StarKist Foods' Corporate Safety Manager conducted a 16-hour safety training program for all department managers in May of 1993 and approximately 60 line supervisors in July of 1993. The Corporate Environmental Manager conducted the 3-hour Hazard Communication portion of the Safety Training.

Heavy Metals. The sources of heavy metals have been addressed in StarKist Samoa's report to US EPA dated July 30, 1991. In this report, the sources of heavy metals are from the Bay water which is used by the cannery for thawing frozen fish.

Since the submission of this report on heavy metals, StarKist Samoa relocated the thaw water intake to a distance of 80 feet from shore and at a depth of 20 feet in December of 1991. The analyses of metals in the thaw water showed the levels of cadmium, chromium, lead, mercury and zinc have all significantly reduced since extension of the intake pipe. See Table 1 below.

Two samples of StarKist Samoa's effluent collected on February 17, 1993 and June 29, 1993 showed concentrations of cadmium, chromium,lead and mercury to be **below** detection limits. Zinc concentrations in the effluent were 0.092 mg/l and 0.147 mg/l respectively.

Table 1

	Jan 90	Nov 90	July 90	Before Average	After Jan 92
Cadmium	0.060	0.059	0.030	0.050	0.010
Chromium	0.200	0.120	0.170	0.160	0.030
Lead	0.700	0.170	0.370	0.413	0.010
Mercury	0.005	0.042	0.002	0.016	0.004
Zinc	0.210	0.270	0.220	0.233	0.045

All concentrations in mg/l.

D:\samoa\report.ppp

Rcd 3/29/93 mike ASEPA

StarKist Samoa, Inc.

P.O. BOX 368 PAGO PAGO, AMERICAN SAMOA 96799

(684) 644-4231
FAX NO: (684) 644-2440

March 22, 1993

Pat Young (E-4)
US EPA Region 9
75 Hawthorne Street
San Francisco, CA 94105

Sheila Wiegman
American Samoa EPA
Office of the Governor
Pago Pago, AS 96799

Subject: StarKist Samoa's Storm Water Pollution Prevention Plan

StarKist Samoa Inc. hereby submits its Storm Water Pollution Prevention Plan as required by its Storm Water General Discharge Permit ASR00A001.

Please call William Adams at 684-644-4249 if you have any questions.

Sincerely,

Maurice W. Callaghan
General Manager

Attachment

cc: B. Mills
Wm Adams
R. Ward
N. Wei

STORM WATER POLLUTION PREVENTION PLAN

Prepared by

StarKist Samoa Inc.
Pago Pago, American Samoa

for

Storm Water General Discharge Permit ASR00A001

Storm Water Pollution Prevention Plan

Introduction

This Storm Water Pollution Prevention Plan (SWPPP) is prepared in compliance with the requirements of StarKist Samoa Inc.'s Storm Water General Discharge Permit.

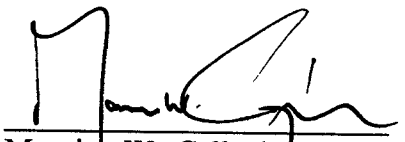
The plant has in place a program of capital improvement to prevent, to the greatest extent possible, process water from coming into contact with storm water which discharges directly to the receiving waters.

Section 1

Storm Water Pollution Prevention Plan Certification

The following is StarKist Samoa Inc.'s Storm Water Pollution Prevention Plan Certification pursuant to the requirements of its Storm Water General Discharge Permit # ASR00A001.

As General Manager of StarKist Samoa, I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.



Maurice W. Callaghan
General Manager

April 1, 1993

Section 2

Storm Water Pollution Prevention Team

Mr. Maurice Callaghan, as the General Manger and Officer of the facility, has overall responsibilities for ensuring that the SWPPP is developed and maintained.

In compliance with the General Permit's requirements, Management at StarKist Samoa has established a Storm Water Pollution Prevention Team for the purpose of developing and implementing a Stormwater Pollution Prevent Plan (SWPPP) and ensuring that the plan is implemented, maintained and updated on a regular basis.

The following individuals are members of this team:

Team Leader: Mr. William Adams. Manager of Engineering. Phone Number (684) 644-4249. He is responsible for all engineering projects at the plant as well as preventive maintenance. He reports to the Manger of Operations, Mr. Barry Mills who has overall responsibilities for production, fleet, and engineering.

Team Member: Mr. Russell Riddell. Superintendent of General Maintenance. Phone Number (684) 644-4231. He is responsible for general maintenance of the plant and reports directly to Mr. Adams.

Team Member: Ms Helen Tisalona. Supervisor of wastewater treatment plant. Phone Number (684) 644-4231. She is responsible for operation of the wastewater treatment plant and reports to Mr. Adams through the Superintendent of Utilities.

Section 3

Site and Storm Drainage Description

Site Description

The site is located in the Village of Aua, American Samoa. The site addressed in this SWPPP includes the tuna packing room, cold storage, auto shop, dock area, warehouses and the wastewater treatment plant. Included are the can manufacturing plant and the tank farm located on the hill side across the public roadway from the main cannery. For the purpose of the SWPPP, the site also includes a public access roadway between StarKist Samoa Inc. and Samoa Packing Company.

Drainage System Description

In general, there is a wastewater drainage ditch along the length of the dock area which drains into a sump near the butchering area. The dock also has an 8-inch high berm which prevents any storm water or process water from reaching the Bay. Any spillage on the dock will drain into the sump and be pumped into the wastewater treatment plant.

Locations of industrial activities are indicated on the map. The direction of flow is generally towards the Pago Pago Harbor. The site map in Figure 1 shows five (5) active storm water outfalls numbered from 1 to 5. General description of each outfall and on-going plans for improvement are outlined below:

Outfall #1: This is a 4' by 2' concrete outfall that originates from the public roadway and extends underneath the west alley way on the site. The only one sump which is connected to this outfall will be sealed off to prevent any runoffs from entering the outfall. All storm runoffs in the west alley area will then be diverted into the wastewater drain along the dock area.

Outfall #2: This storm water outfall originates from the public roadway and runs underneath the entire length of the site. Since there are no connecting points on site, there is no possibility of process water coming into contact with the storm water in the outfall.

Outfall #3: This outfall starts at the entrance gate near the warehouse and runs under the middle access alley. This outfall carries rain water from the roofs. There are three open gratings that access the drain and they will be sealed off. Seals will be placed around the downspouts into this storm drain to ensure that only storm water from the roofs can gain access to this outfall. The drain cover at the dock end will also be sealed off so that no process water in the dock area can get into this outfall inadvertently.

Outfall #4: This outfall carries rain water from the roofs of the packing room. As with Outfall #3, seals will be placed around all the downspouts as added assurance to prevent process water from getting into the storm water.

Outfall #5. This existing outfall originates from Samoa Packing's truck dock and runs underneath the East Alley which is a public access road between the two canneries. In addition to carrying Samoa Packing's truck dock water, this outfall also collects roof water from Samoa Packing which runs onto the alley. A storm water sump outside StarKist's retort room picks up rain water which falls on the alley. Near the wastewater treatment plant area, there is a storm water drain which connects to Outfall #5. StarKist's SWPPP will divert Samoa Packing's truck dock and roof drain to the drainage ditch near the wastewater treatment plant which will be relocated further up stream to intercept rain water.

Impervious and Total Areas

The site encompasses a total of approximately 355,000 square feet of which 99 percent is impervious. The only area that is not impervious at present is the containment area around the tank farm on the hill. It is approximately 4,000 square feet in area.

The following is a breakdown of the approximate square footages for each major area at the site:

Dock Area	36,500 sq ft.
East Alley	13,500 sq ft.
Can Plant	37,600 sq ft.
Cannery	260,000 sq ft.
Auto shop	6,800 sq ft.
Tank farm	4,000 sq ft.

Non-Storm Discharges

The only non-storm discharge from the plant is StarKist Samoa's treated wastewater which is discharged some 8,000 feet from the inner Pago Pago Harbor through a pipeline and diffuser under US EPA NPDES Permit# AS0000019.

Section 4

Description of Potential Storm Water Pollutant Sources

Materials Storage

Significant materials present at StarKist Samoa Inc. have been identified based on information provided by staff personnel familiar with the operation of the facility. Chemicals used in significant quantities are chlorine, anhydrous ammonia, sodium hydroxide and miscellaneous solvents. Large quantities of non-toxic, non-phosphate and FDA-approved detergents are kept by the Quality Control Department. Small quantities of automotive and hydraulic oils are kept in the auto shop. All of these chemicals are kept either indoors in a dry location or are under cover. The possibility of these chemicals getting into the strom water drains is zero.

Laboratory grade chemicals used for chemical analyses at the Quality Control Laboratory are stored in fireproof cabinets in the lab and there is no possibility of these chemicals spilling into the storm water drains.

The primary raw material for the cannery is frozen tuna which is off loaded from fishing vessels at the dock and taken directly into freezers for cold storage. All porcess water and rain water on the dock are collected by in the wastewater drainage ditch and pumped to the treatment plant.

StarKist Samoa has an on-going program of shipping hazardous wastes (spent sovents) off island to Treatment Storage and Disposal Facilities (TSDF) in the mainland for proper disposal. The plant generates less than 1000 kg of hazardous wastes per month and is considered a Small Quantity Generator under US EPA regulations. The hazardous wastes storage area is indoor and does not come into contact with storm water. Every 55-gallon drum containing hazardous waste is placed inside an 85-gallon overpak drum for secondary containment.

Outdoor storage of significant materials used at the site is not common at StarKist Samoa. Materials found outdoors are limited to miscellaneous dry garbage such as cardboard and off-specs tuna cans.

The materials that are stored, handled or used onsite and which have the potential to be released with storm water discharges are as follows:

1. The tank farm behind the Can Plant. The Tank Farm contains three soybean oil tanks, two fuel tanks, four water tanks, and three spring water tanks. The soybean tank each has a capacity of 42,000 gallons. One fuel tank has a capacity

of 7,500 gallons and contains #2 fuel. The other fuel tank has 42,300 gallons of #5 oil when full. The soybean oil tanks, the fuel tanks and two water tanks are located within the perimeters of a containment wall.

The largest water tank holds 365,000 gallons and is intended for fire fighting use. There is one 87,500-gallon tank that hold potable water and two 39,700-gallon tanks for recovered water. The spring water tanks each has a capacity of 4,400 gallons.

2. The wastewater treatment storage tanks. The wastewater treatment area has one 200,000-gallon surge tank for wastewater, one 86,000-gallon cold water storage tank which holds thaw water, one 200,000-gallon tank for high strength wastes (cooker juice, press liquor and DAF sludge). The integrity of these tanks are checked on a regular basis. Preventive maintenance was performed on the 200,000 gallon surge tank in December of 1992. Small quantities of wastewater treatment chemicals such as aluminum sulfate and polymer are kept outdoors for immediate usage. Any overflow or spillage from the treatment plant area will be intercepted by the wastewater drainage ditch and pumped back into the treatment plant.

Annual Runoff

American Samoa receives an average of 200 inches of rain a year. Based on a drainage area of approximately 360,000 square feet and a runoff coefficient of 0.90, it is estimated that the annual runoff from the site is 5.4 million cubic feet or 40 million gallons.

Spill History

There have been no spills of toxic chemicals discharged to the storm water system or release of other substances in reportable quantities since November 19, 1988 to the present.

Existing Storm Water Data

Storm water data have been collected on one of the storm water outfall (#3) from February 1991 to February 1992. Table 1 contains the data summary.

Table 1: Storm Water Data

	Temp	Turbidity (NTU)			Oil & Grease (mg/l)		
		Min	Average	Max	Min	Average	Max
Feb 91	80.2	1.3	1.5	1.7	18.0	21.0	23.9
Mar 91	78.3	7.0	6.4	11.9	23.9	39.5	28.4
Apr 91	82.0		9.5			26.2	
May 91	82.7	5.2	7.8	10.3	4.6	5.6	6.6
Jun 91	82.0	9.5	17.5	25.5	12.7	28.8	44.9
Jly 91	72.0	13.1	38.6	64.0	11.7	53.3	41.6
Aug 91	78.9	5.9	9.5	13.1	1.0	1.2	1.4
Sep 91	81.5	15.0	17.8	20.6	5.0	11.1	17.1
Oct 91	81.8	25.8	28.8	31.7	27.0	37.5	48.0
Nov 91	72.5	14.4	16.0	17.5	5.0	8.4	11.8
Dec 91	77.0	10.4	24.8	39.3	25.7	26.6	27.6
Jan 92	79.8	8.5	16.0	23.4	3.5	6.0	9.7
Feb 92	80.2	7.5	17.2	26.9	6.3	9.6	12.9

Only one data point was collected during the month of April 1991. Samples were taken as composites made up of grab samples every 15 minutes.

Section 5

Existing Storm Water Best Management Practices

StarKist Samoa employs a variety of materials, equipment and good housekeeping practices to minimize contact of storm water with industrial process water and materials.

New Roof Gutters

During 1992 and in anticipation of the storm water general permit, StarKist Samoa undertook some major structural modifications to ensure that process water does not come into contact with storm water. New gutters for rain water have been installed along the roofs throughout the plant. The capital cost for this undertaking was approximately a million dollars.

Preventive Maintenance

The Engineering Department currently uses an automated computerized system known as TRI-MAX for tracking spare parts and scheduling maintenance throughout the plant. The cost of this system is approximately $250,000.

TRI-MAX operates as follows: When a new item of equipment is installed, its specifications and manufacturer's recommended maintenance schedule are entered into this system. At the time when the scheduled maintenance is due, TRI-MAX automatically issues a work order starting the location and type of maintenance needed. This work order is routed to the appropriate department responsible for that piece of machinery. Once the maintenance is done, the work order is signed off and the details are entered into the computer as part of a "maintenance history" for that piece of machinery. TRI-MAX continues to issue work orders automatically until such time as the needed maintenance work has been completed and signed off. A computer report on open or un-finished work orders is issued to enable management to follow-up on any outstanding or overdue maintenance work.

The plant also conducts semi-annual detailed inspections of pipes, pumps, valves and fittings, tank corrosion (internal and external), tank support or foundation deterioration, stains on walls, stains along drainage ditches and old tanks, deterioration of primary or secondary containment, housekeeping, drain valves on tanks, damage to shipping containers, conveying systems for dry chemicals, integrity of stormwater collection system, leaks, seepage, and overflows from sludge and various waste disposal sites.

General Good Housekeeping Practices

As part of the ongoing SWPPP, the Team will ensure that the following day-to-day good housekeeping practices are maintained at all times:

1. Chemicals are to be stored in a neat and orderly fashion.
2. Any small spillage is promptly removed. There is minimum accumulation of liquid and solid chemicals on the ground or floor in a building.
3. Garbage and rubbish are picked up and disposed of regularly.
4. The floors are kept dry and clean by use of brooms, vacuum cleaners, etc.
5. Pathways and walkways are maintained properly with no containers and drums protruding onto walkways.
6. Employees are encouraged to maintain interest in good housekeeping.

Spill Prevention and Response Procedures

Material Handling Procedures. Most chemicals and materials brought into the facility are unloaded using fork lift trucks. The operators will exercise skill and care when handling such material. Since delivery trucks always backs up flush to the loading dock, a spill would have to occur near to the edge of the loading dock for the material to get into the ground and the storm system.

Storage Requirements. All of the chemicals and most of the materials in use are stored inside the plant . Materials that are stored outside and generally under cover.

Cleanup Equipment and Procedures. Cleanup equipment and sorbent materials are kept in the stock room and in the vicinity of the potential spill areas. In the event of a spill, the personnel will follow the manufacturer's guidelines on spill cleanups.

Record keeping and Reporting of Spills Records of spills through formal reports are maintained for internal review at the Engineering Office by plant management. Governmental and environmental agencies are notified immediately should a spill reaches the Pago Pago Harbor.

In the event of emergencies related to chemical spills, the following persons are notified:

StarKist Samoa Official: Mr. William Adams. Manager of Engineering. Office number (684) 644-4249; Residence number: (684) 644-1238.

Government officials: Ms Sheila Wiegman. AS EPA. Office number: (684) 633-2304.

StarKist Seafood Official: Mr. Norman Wei. Senior Manager of Environmental Engineering. Office number: (310) 590-3873; Residence number: (714) 969-6129.

Security

Security at the plant is provided by a private security firm. Entrances to the plant property are controlled by manned guard houses on a 24-hour basis. Both vehicular and personnel traffic are controlled by security guards. Visitors are required to obtain Visitor's Passes. Locks are placed on drain valves and pumps for chemical storage tanks.

Annual Site Inspection and SWPPP Review

A formal site inspection shall be conducted annual by a member of the Storm Water Pollution Prevention Team to verify that the description of potential pollutant sources is accurate. The controls currently in place will also be reviewed and updated. Records documenting significant observations made during the annual site inspection and corrective actions resulting therefrom will be retained as part of the SWPPP for a period of five (5) years.

Sediment and Erosion Prevention

Vegetation is maintained on the hill side near the tank farm to ensure proper sediment and erosion control.

Employee Training

Regular meetings of employees will be held to assure adequate and standing of program goals and objectives.

An annual training program to inform StarKist personnel at all levels about the goals and components of the SWPPP as well as a general environmental awareness program will be implemented. The topics addressed in the training, the frequency of training sessions and the categories of employees who will be attending such training programs are listed in Table 2.

Every employee who has completed such training will receive a certificate from the Supervisor and acknowledge receipt of such training. Records of training will be kept on file by the Storm Water Pollution Prevention Team.

Section 6

Future and On-Going Storm Water Management Control Program

This section describes the role of the Storm Water Pollution Prevention Team as well as StarKist Samoa's on-going capital improvements designed to essentially eliminate any future contact of storm water with process water.

Role of the Storm Water Pollution Prevention Team

The StarKist Samoa SWPPP team has been charged with the responsibility of ensuring that the following tasks are carried out:

1. Coordinate with other departments to ensure that an up-to-date inventory of hazardous materials is maintained.

2. Establish spill reporting procedures and programs for visually inspecting plant facilities. Conduct routine (daily and weekly) visual inspection of potential spill sources such as tank and chemical storage areas and the loading dock areas. Inspection findings will be kept in a log book.

3. Coordinate with all departments in carrying out the goals of the existing Best Management Plan (BMP).

4. Establish guidelines for employee training and awareness programs.

5. Review of new construction and process changes which might have an impact on spill prevention and storm water management control.

6. Coordinate employee training on spill responses, good housekeeping, and material management practices.

Planned Capital Improvements

A capital improvement program is currently under way to seal off all pipe connecting points in the cannery. This would prevent process water from commingling with storm water. This program will also include sealing off eight unused and abandoned pipes underneath the dock, placing roofs over temporary chemical storage areas, making impervious the spill containment area in the tank farm, and re-surfacing access road at the West end of the Can Plant to improve safety.

The cost of this capital improvement program is estimated to be in excess of $400,000.

Table 2: Training Program

The following are components of a training program to be instituted by management for plant employees.

- Periodic Spill drills.
- Preventive maintenance.
- Pollution prevention measures.
- Spill prevention and response procedures
- Input and encouragement from management.
- Training in general good housekeeping practices.
- General overview of environmental laws and regulations.
- Transmission of knowledge of past spills and causes through case studies.
- Making employees aware of BMP program.
- Review of operating manuals and standard operating procedures.
- Review and interface with health and safety program on associated health risks of chemicals handled.

Section 7

Monitoring Requirements and Revision of SWPPP

Annual Inspection

StarKist Samoa does not have any storm water discharges associated with industrial activities that allow storm water to come into contact with any equipment, tank, container or other vessel or area used for storage of a Section 313 water priority chemical. All such chemicals are stored either indoors or under cover and do not come into contact with storm water discharges.

A formal site inspection shall be conducted annually by a member of the Storm Water Pollution Prevention Team to verify that the description of potential pollutant sources is accurate; that the site map has been updated or modified to reflect current conditions; and that the controls to reduce pollutants in storm water discharges associated with industrial activities identified in this SWPPP are implemented.

Records documenting significant observations made during the site inspection and any corrective actions resulting from the inspection will be retained on file as part of the SWPPP for a period of five (5) years.

This formal site inspection shall be documented by using the inspection sheet in Table 3. A copy of Visual Inspection Guidelines is also attached.

Revision of SWPPP

The SWPPP will be revised and updated by the Storm Water Pollution Prevention Team as needed.

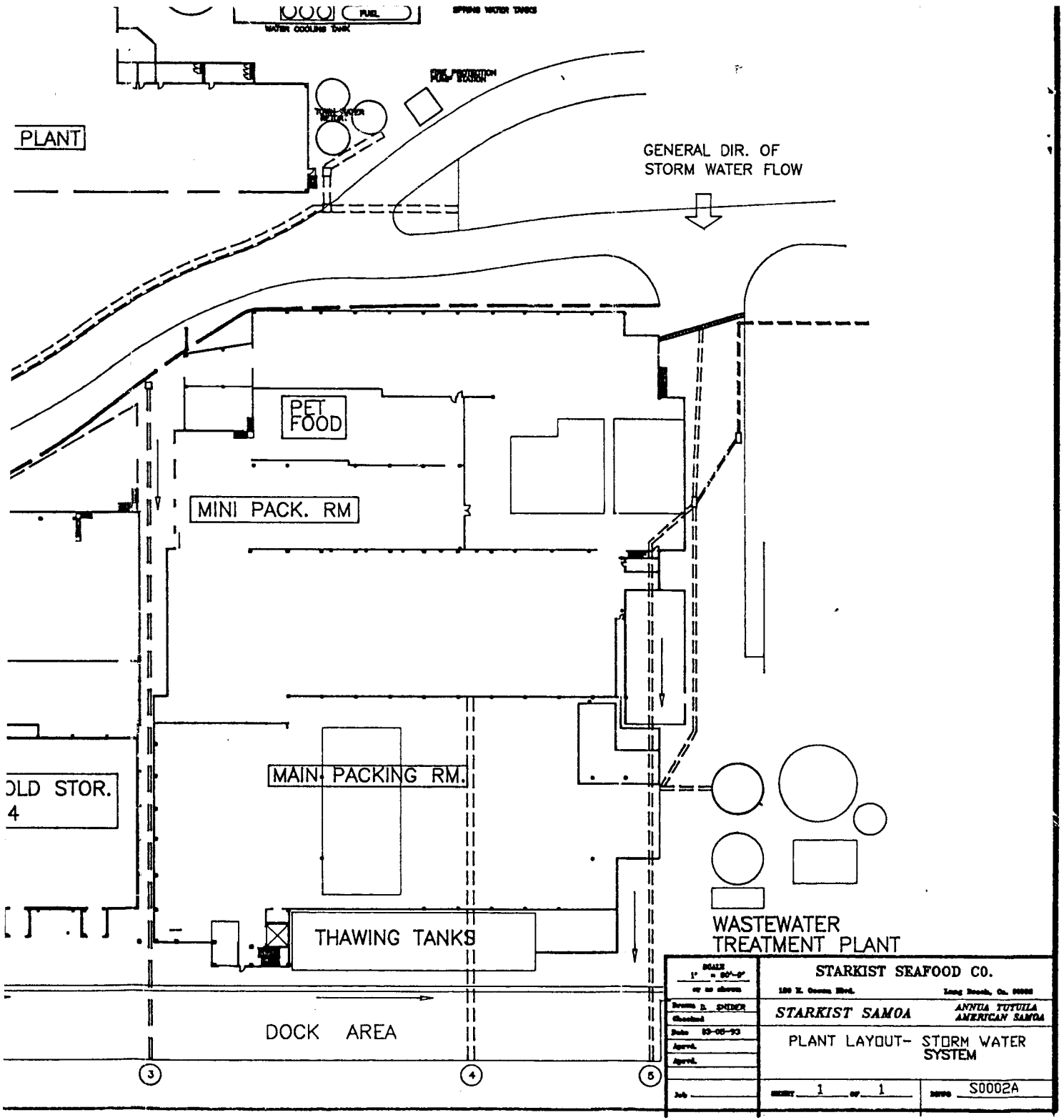
Table 3

Annual Storm Water Inspection Log

StarKist Samoa Inc. Pago Pago, American Samoa		Date: Inspector:	
Location	**Observation**	**Suggested Action**	**Completion Date**

Visual Inspection Guidelines

	Equipment to Inspect
■	**Pipes**
■	**Pumps**
■	**Storage Tanks and Bins**
■	**Pressure vessels and pressure release valves**
■	**Process and material handling equipment**
	Area to Inspect
■	**Areas around all of equipment listed above**
■	**Areas where spills and leaks have occurred in the past**
■	**Material storage areas (tanks, drum storage)**
■	**Outdoor material processing areas**
■	**Material handling areas**
■	**Wastewater treatment area**
	Visual Inspection Checklist
☐	**Corroded drums**
☐	**Corroded or damaged tanks, tank supports and tank drain valves**
☐	**Torn bags or bags exposed to rain water**
☐	**Leaking or improperly closed valves and valve fittings**
☐	**Broken or cracked curbs, walls or barriers**
☐	**Wind-blown dry chemicals**


PLANT
GENERAL DIR. OF
STORM WATER FLOW
PET
FOOD
MINI PACK. RM
MAIN PACKING RM.
OLD STOR.
4
THAWING TANKS
WASTEWATER
TREATMENT PLANT
DOCK AREA
3
4
5
STARKIST SEAFOOD CO.
STARKIST SAMOA
ANNUA TUTUILA
AMERICAN SAMOA
PLANT LAYOUT- STORM WATER
SYSTEM
S0002A

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

14 SEP 1992

In Reply
Refer To: W-5-1
Certified Mail:

Maurice Callaghan
Star-Kist Samoa, Inc.
P.O. Box 368
Pago Pago, Tutuila
American Samoa 96799

Dear Mr. Callaghan:

Enclosed is a copy of a National Pollutant Discharge Elimination System (NPDES) permit for the following discharger:

Star-Kist Samoa, Inc.
NPDES Permit No. AS0000019

The staff at the Environmental Protection Agency (EPA) has reviewed the NPDES permit application for these facility and has prepared draft permits, in accordance with the Clean Water Act. The EPA has also published public notices of its tentative decisions to issue permits to the above dischargers. After considering the expressed views of all interested persons and certification of the draft permits, the EPA, pursuant to 40 CFR 124, has prepared final permits which do not differ significantly from the draft permits.

During the public comment period, several comments were submitted to EPA on the proposed draft permits. Enclosed is EPA's response to these comments. Please see the enclosed statement "Response to Comments."

The NPDES permits are hereby issued upon the date of signature and shall become effective 33 days from the date of this cover letter, unless there is written request for an evidentiary hearing. Pursuant to 40 CFR 124.76, requests for an evidentiary hearing must state each of the legal or factual question alleged to be at issue and must demonstrate one of the following for each issue being raised in the hearing request: that the issue was raised during the public comment period; that the issue was not reasonably ascertainable during the public comment period; or the requester could not have reasonably anticipated the relevance or materiality of the issue during the comment period. Any request for an evidentiary hearing must be submitted within 33 days from the date of this cover letter to Steven Armsey, Regional Hearing Clerk (RC-1), at the above address.

The EPA will routinely deny any evidentiary hearing request which is postmarked later than the 33rd day from the date of this cover letter. Also, the EPA will routinely deny any evidentiary hearing request which raises only legal issues. Any denial of a request for an evidentiary hearing may be appealed to the Administrator within 30 days from the date of notice of the denial. The requestor must exhaust all administrative review before seeking judicial review.

If you have any questions regarding the procedures outlined above, please call Doug Liden at (415) 744-1921 or Pat Young at (415) 744-1591.

Sincerely,

Terry Oda, Chief
Permits Issuance Section

Enclosure

cc:
Pati Faiai, ASEPA
Norman Lovelace, USEPA
Henry Sesepasara, Dep. of Marine and Wildlife Resources
Norman Wei, Star-Kist, Inc.
Jim Cox, VCS Samoa Packing Co.
Steve Costa, CH2MHill

Response to Comments

VCS Samoa Packing Company
NPDES Permit No. AS0000027

Star Kist Samoa, Inc.
NPDES Permit No. AS0000019

Comments on the draft permits for these facilities were received from the dischargers through their consultant, CH2MHill, on April 22, 1992. These comments pertained to both permits and will be addressed together. One comment was also received from Department of Marine and Wildlife Resources. The response to that comment is found under Section F.

Section A. Effluent Limits and Monitoring Requirements

1. Monitoring for Total Nitrogen (TN) and Total Phosphorus (TP)

The canneries' comments related to the monitoring schedule in the draft permit for monthly averages for TN and TP which provided the option of counting non-production day discharges by requiring seven consecutive days of monitoring (six days following the monitoring of a non-production day). It was suggested that this approach was overly conservative, expensive, and that a weighted average procedure be used in calculating production and non-production day loadings for monthly averages.

Response: The method proposed in the draft permit for monitoring and calculating monthly averages for TN and TP is straight-forward (i.e. all sampling days are totaled and averaged and does not use weighted averages) and yet still allows the canneries to account for non-production days in order to lower their monthly average if necessary. Thus, the monitoring requirement will stand as is.

Should the canneries consistently comply with their TN and TP limits and should the monitoring data show that the discharge is not significantly affecting the water quality in the harbor or causing receiving water quality violations, the permit may be modified to incorporate a "weighted average" method of measuring compliance with the limitations. The numerical limitations themselves shall not be made any less stringent.

2. Monitoring Requirements for Total Residual Chlorine (TRC)

The canneries commented that the TRC limit did not account for quenching effects on TRC as it travels through the outfall. They requested that procedures be developed to test these effects and the results used to determine if a

compliance problem with TRC standards in the receiving waters exists. Additionally, guidance was requested from USEPA on acceptable analytical procedures and instrumentation for measuring such low levels of TRC.

Response: The USEPA's Environmental Support Branch (ESB) was consulted and based on their recommendation, the TRC monitoring requirement has been removed from the permit. In ESB's opinion, the quenching effect and high organic content of the effluent, as well as the salinity of the effluent and receiving waters, would likely result in a negligible amount of TRC discharged into the harbor. This permit may be reopened for the inclusion of such a monitoring requirement and a limitation should an approved EPA method be developed and conditions indicate that TRC is present in the effluent.

3. Monitoring Requirements for pH

As requested, the condition regarding monitoring requirements for pH which was included in the previous permits will be retained in the present permits.

4. Total Nitrogen (TN) and Total Phosphorus (TP) Combined Loading

The canneries requested that total allowable loading for TN and TP in the mixing zone be used as the criterion for determining violations of permit conditions for these parameters. Under such an arrangement there would be no violation unless the total loading for both canneries was exceeded.

Response. Although the canneries share a joint outfall and zone of mixing, each cannery is being issued its own NPDES permit, and thus is responsible for meeting the limitations described in its individual permit. For enforcement purposes, each permit must stand as an independent and enforceable contract. The "bubble approach", was employed in these permits by allowing the canneries to effectively determine their own limitations by allocating the total end-of-pipe limitations for nutrients.

Section B. Discharge Specifications

The canneries expressed concern that the receiving water monitoring discharge "shall not reveal" specifications for certain parameters was vague, and that the permits implied that the canneries would be held responsible for violations of water quality if the monitoring revealed any of the listed items, without consideration of other pollutant sources such as nonpoint sources, stream runoff, etc.

Response. While we agree that the canneries should not be held responsible for ambient excursions above water quality standards that are in no way linked to the canneries' discharge, the canneries are responsible for providing proof that their discharges are not responsible for such excursions. Such clarifying language has been added to the permit.

Section C. Protected and Prohibited Uses

The canneries felt that the permit language should specify that this section applied to their discharge as they should not be held responsible for other parties engaging in prohibited uses or compromising the protected uses of the harbor.

Response. The canneries are not held responsible for another party engaging in prohibited uses. Such language clarifying the canneries' responsibilities has been added.

Section D. Toxicity

The canneries requested that the language of the first sentence of Part 3 (Toxicity Reopener) to modified to add the word "materially", so that it would read, "Should any of the monitoring indicate that the discharge causes, has reasonable potential to cause, or contributes **materially** to an excursion above a water quality criteria,...."

Response. The language in the proposed permit is a direct implementation of American Samoa's water quality standards. The language shall remain as stated.

Section E. Receiving Water Quality Monitoring Program

The canneries requested that the permit include the possibility of modification/elimination of monitoring stations, with appropriate review, after the first year of monitoring. They felt that if the first year of monitoring indicated that water quality standards were being met throughout the harbor, then only those stations in and at the edge of the mixing zone would be needed to monitor compliance.

Response. The number and location of stations is important to assess the cause of a water quality exceedance and to assess farfield dilution. Therefore, a greater number of stations is beneficial both to the regulators and to the canneries. The number and location of sampling stations shall remain as stated.

Section F. Dye or Tracer Studies

The canneries suggested that the dates for these studies be determined during development of the study plans so that the studies would be conducted at the appropriate time, during the two distinct oceanographic seasons. They also suggested that the second study requirement be contingent upon an assessment of the first study's results.

Response. We agree with the rationale behind determining the date of the dye study during the development of the study plan. However, the date must be approved by ASEPA and USEPA and is to occur no later than six months after the issuance of this permit.

A second study shall be required regardless of the results of the first study. The purpose of these studies is to evaluate the two extreme conditions (i.e. no current and a current towards the coral reef.) One study would not be enough to ascertain two such conditions.

Department of Marine and Wildlife Resources recommended that the "new" water quality sampling stations be determined after the results of dye/tracer studies are obtained because "the results may show differential plume dispersal which would be useful in sample site selection."

Response: The purpose of the new sites are to determine compliance with the water quality standards at the applicable locations (either within or at the boundary of the mixing zone). The "new" sites are therefore established at those locations. The permit does include a reopener clause for the inclusion of additional monitoring stations should the results of any of the studies or monitoring program warrant it.

Section G. Sediment Monitoring

The canneries felt that yearly sediment sample studies may not be necessary and suggested that the results of the first two years of monitoring be assessed and the necessity of annual sampling be determined at that time.

Response. We agree with this suggestion and the permit language has be revised accordingly.

Section H. Eutrophication Study

As per the canneries' comment, the phrase "phytoplankton species" has been clarified to "phytoplankton **communities**".

Section I. Coral Reef Survey

The canneries suggested less frequent coral reef surveys be undertaken in order to detect meaningful differences and that a revised study plan should be made after the first survey, which would specify the timing of the subsequent surveys.

Response. The intent of this requirement was to provide baseline data and two subsequent surveys for comparison over the period of the permits (5 years). Thus, the first survey should be done as stated (within the first year of permit issuance) and the next study should be performed within two years of the first study and biannually thereafter.

Section J. Verification of Model Predictions

The canneries' suggestion requiring a study plan be approved to verify model predictions will be incorporated in the permit. This will ensure coordination between all parties and that all needs are met meaningfully.

ROUTING AND TRANSMITTAL SLIP

Date: 9/3/93

TO: (Name, office symbol, room number, building, Agency/Post)	Initials	Date
1. Robyn Stuber (W-5-1)		
2. Dave Stuart (W-7-1)		
3.		
4.		
5.		

	Action		File		Note and Return
	Approval		For Clearance		Per Conversation
	As Requested		For Correction		Prepare Reply
	Circulate		For Your Information		See Me
	Comment		Investigate		Signature
	Coordination		Justify		

REMARKS

• Final report for first Coral reef survey. I will prepare response re: their responses to our comments on 1st study plan. Any comments you have should be given to me by [redacted]. Thanks.
10/11/93

DO NOT use this form as a RECORD of approvals, concurrences, disposals, clearances, and similar actions

FROM: (Name, org. symbol, Agency/Post)	Room No.—Bldg.
Pat Young E-4	Phone No. 1594

5041-102

OPTIONAL FORM 41 (Rev. 7-76)
Prescribed by GSA
FPMR (41 CFR) 101-11.206

★ U.S. GPO: 1990 — 262-080

CORAL REEF STUDY
Rcd 9/2/93
Copy to Robyn Stuber, Dave Stuart.
Copy of letter only M. Lee

CH2M HILL Engineers Planners Economists Scientists

30 August 1993

PDX30702.RS.R1

Patricia N.N. Young
American Samoa Program Manager
Office of Pacific Islands and Native American Programs
U.S. Environmental Protection Agency
75 Hawthorne Street (E-4)
San Francisco, California 94105

Dear Pat:

Subject: Joint Cannery Outfall: Final Report for the First (February 1993) Coral Reef Survey Study

Enclosed are three copies of the final dye study report for the first Coral Reef Survey conducted in February 1993 in Pago Pago Harbor. The reef survey indicated no effect of cannery discharge in the middle or outer harbor. There was no observed change in the reef habitat in the inner harbor. The results are as anticipated. The effluent plume is trapped well below the reef survey area which extends to 60 feet and does not directly affect the reef area. Any changes in the inner harbor are expected to be slow.

The original coral reef survey study plan is attached as an addendum to the dye study report with our responses to comments on the study plan. **We have not identified any changes to the original study plan for the second reef survey (February 1995).** If you have any questions or comments please call me at your convenience. I have sent the same information to Sheila Wiegman of ASEPA.

Sincerely,

CH2M HILL

Steven L. Costa, Project Manager

enc: 3 copies of February 1993 coral reef survey study report

cc: Norman Wei, StarKist Seafood Co.
James Cox, Van Camp Seafood Co.

CH2M HILL 1111 Broadway, P.O. Box 12681, Oakland, CA 94604-2681 510.251.2426 Fax 510.893.8205

JOINT CANNERY OUTFALL CORAL REEF SURVEY REPORT
February 1993 Survey

NPDES Permits AS0000019 & AS0000027

StarKist Samoa, Inc. and
VCS Samoa Packing Company
Pago Pago, American Samoa

August 1993

Prepared By
CH2M HILL

EXECUTIVE SUMMARY

The first of the required biannual coral reef surveys has been conducted in Pago Pago Harbor in fulfillment of NPDES permit conditions. The survey was conducted during February 1993. A total of 19 locations throughout the harbor were surveyed as follows:

- Thirteen transects at six locations in the inner harbor
- Twenty seven transects at eight locations in the middle harbor
- Fifteen transects at five locations in the outer harbor

The required series of coral reef surveys is designed to provide data needed to evaluate potential impacts of treated wastewater discharge from the Joint Cannery Outfall on the nearby coral reef. The coral reef surveys provide information needed to evaluate and detect significant differences, if any, from an earlier survey done in January of 1991. The survey sites and data collected in February 1993 were consistent with the 1991 study.

The survey was done by making video recordings of transects at multiple depths at each site. The video recordings were then analyzed and summarized by a qualified marine ecologist with expertise in coral reef taxonomy and previous experience in American Samoa. The survey data are presented in terms of estimated hard coral coverage and the number of hard coral species identified for each transect.

Prior to February of 1992 the discharges from the canneries were through two short outfalls in the inner harbor. The discharge point for the canneries was relocated to the outer harbor using a joint outfall. In addition, the canneries instituted high strength waste segregation, using an EPA approved ocean disposal site for the high strength wastes, in August of 1990. Comparison of the survey data for the inner harbor indicate no change in conditions between the 1991 and 1993 surveys. One of the survey transects is located approximately 600 feet from the new outfall location. No evidence of wastewater impacts or settleable solids was observed at this station.

Any impacts to coral reef communities due to high strength waste segregation or outfall relocation are expected to be long term and difficult to distinguish from variability due to other factors. The results from the first coral reef survey support this expectation. The major observations based on the results of the first survey include:

- The inner harbor seabed consists of silty muds and areas of silt covered remnant coral structures. No apparent changes to the seabed conditions were observed between the 1991 and 1993 surveys.

- The north-shore reef face between Trading Point and Leloaloa in the inner harbor represents a transition zone with less than 5-percent live hard coral recorded in both 1991 and 1993.

- Middle harbor reef areas exhibited increased sand and silt coverage of surfaces in the 1993 survey, compared to the 1991 survey, probably due to the effects of Hurricane Fay in 1992.

- There is some variability in coverage and number of genera at individual transects at middle harbor sites between the 1991 and 1993 surveys. However there does not appear to be a distinct observable trend and the average live coral coverage and number of genera for all transects combined is nearly the same for both surveys

- Live hard coral coverages and diversity in the middle harbor are generally comparable to the outer harbor reef areas (with the exception of Station OH-2 discussed below). Stations located near stream discharges in both the middle and outer harbor display effects of siltation, including reduced live hard coral coverage and diversity.

- The outer harbor region includes a range of exposed and protected reef areas. With the exception of site OH-2 there appears to be no overall observable trend in the outer harbor. Station OH-2, which is the most exposed site to wave action and close to the mouth of the harbor, exhibited a large apparent increase in live coral coverage.

No apparent trends in reef coral communities or effects of changes in cannery discharge are immediately obvious based on the available data. This is not unanticipated. Changes in the inner harbor are expected to be long term. Since the discharge plume in the outer harbor is trapped deeper than 60 feet most, if not all, of the time, no impact from the relocated discharge is expected in the middle or outer harbor. Additional surveys may provide sufficient information to statistically assess natural variability and variability induced by survey methodology and techniques. This may provide a better data base to evaluate potential impacts of the changes in cannery discharge practices.

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Section 1

INTRODUCTION

This report presents the field survey results for coral reef surveys in the inner, middle, and outer regions of Pago Pago Harbor. This is the first of a series of required surveys and provides a baseline for comparison with future surveys. This work has been conducted to comply with conditions of the United States Environmental Protection Agency (EPA) NPDES Permit No. AS0000019 for Star-Kist Samoa Inc. and NPDES Permit No. AS0000027 for VCS Samoa Packing Company. The coral reef surveys are required under Section I of the NPDES permits, which state the following:

> *"Within six months of the effective date of this NPDES permit, the permittee, in cooperation with {Samoa Packing Co.; Star-Kist Samoa}, shall submit a field study design for approval by ASEPA and EPA Region 9 to assess the potential impacts of the discharge on the nearby coral reef. The study shall include coral reef transects which shall conform to locations found on Figure 4 in the USE ATTAINABILITY AND SITE-SPECIFIC CRITERIA ANALYSES; PAGO PAGO HARBOR, AMERICAN SAMOA, FINAL REPORT (CH2M HILL, March 15, 1991). The intent of this annual survey is to detect significant differences, if any, from the database information found in the above-cited document. Videos shall be submitted to both the USEPA and ASEPA. Guidance for designing such surveys is provided in the Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters November 1982, EPA #430/0-82-010 (pages 70-71). In addition, the discharger should consult Ecological Impacts of Sewage Discharges on Coral Reef Communities, September 1983, EPA #430/9-83-010, for further information. The study shall be conducted within one year of the effective date of this permit and every two years thereafter."*

A Coral Reef Survey Study Plan was submitted for review and approval to the EPA and ASEPA on January 8, 1993. During the development and review of the Coral Reef Survey Study Plan, comments received from USEPA and ASEPA were reviewed and incorporated into the study plan, as necessary, prior to the field data collection. However, the comments were received shortly before the actual filed work and a formal response to comments was not prepared prior to the first survey. The study plan and a formal response comments are provided as an addendum to this report. During the study no substantial recommended changes to the study plan were identified for future surveys.

BACKGROUND

The NPDES permit condition states that coral reef surveys shall be conducted at all of the same sites surveyed during the 1991 Use Attainability Analysis (CH2M HILL, 1991) to detect significant differences, if any, from the 1991 baseline reef survey data. The wastewater discharge locations and methods for the canneries have changed since the 1991 survey. This has had an effect on receiving water conditions throughout the harbor.

In January 1991, when the previous reef survey was conducted, the two canneries operated separate wastewater outfalls in the inner harbor area of Pago Pago Harbor. Currently, Star-Kist Samoa and Samoa Packing operate a joint wastewater outfall that extends over 7,000 feet west from the canneries to a deep-water site offshore of Anasosopo Point in the outer harbor. The outfall consists of a 16-inch HDPE pipe that terminates with a multiport diffuser at a depth of 176 feet below mean lower low water (MLLW). The outfall pipeline route and diffuser location are shown in Figure 1-1. In addition to relocating the discharge the canneries began high strength waste segregation in August of 1990. Since that time cooker juice, press liquor, and cannery sludge have been disposed of at an EPA-approved ocean disposal site.

The January 1991 surveys involved recording reef transects at multiple-depths along the reef fronts at 19 sites located around the entire circumference of Pago Pago Harbor. These 1991 coral reef field surveys were designed to provide comparable records of the reef conditions around the entire harbor for use in an evaluation of reef-face habitat conditions in areas of the inner, middle, and outer Pago Pago harbor. These surveys were designed to provide a semi-quantitative summary of reef corals and other benthic species, and reef fish identifications were incidental.

APPROACH

The approach and methodology for the coral reef survey has been designed to duplicate, to the extent feasible, the 1991 reef video surveys that were conducted at each of the designated sites in Pago Pago Harbor, and to be consistent with available guidance provided in the Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters (USEPA, November, 1982). To meet the NPDES permit conditions, video transects were recorded at multiple depths at each of the nineteen established reef transect sites around Pago Pago Harbor (Figure 1-2). The first coral reef survey was conducted during February 1993. Subsequent surveys are planned for February 1995 and 1997.

The coral reef field surveys were conducted to provide video transect records of the reef conditions around Pago Pago Harbor that can be compared with the 1991 survey and with future surveys at the same locations. These surveys can be used to evaluate the

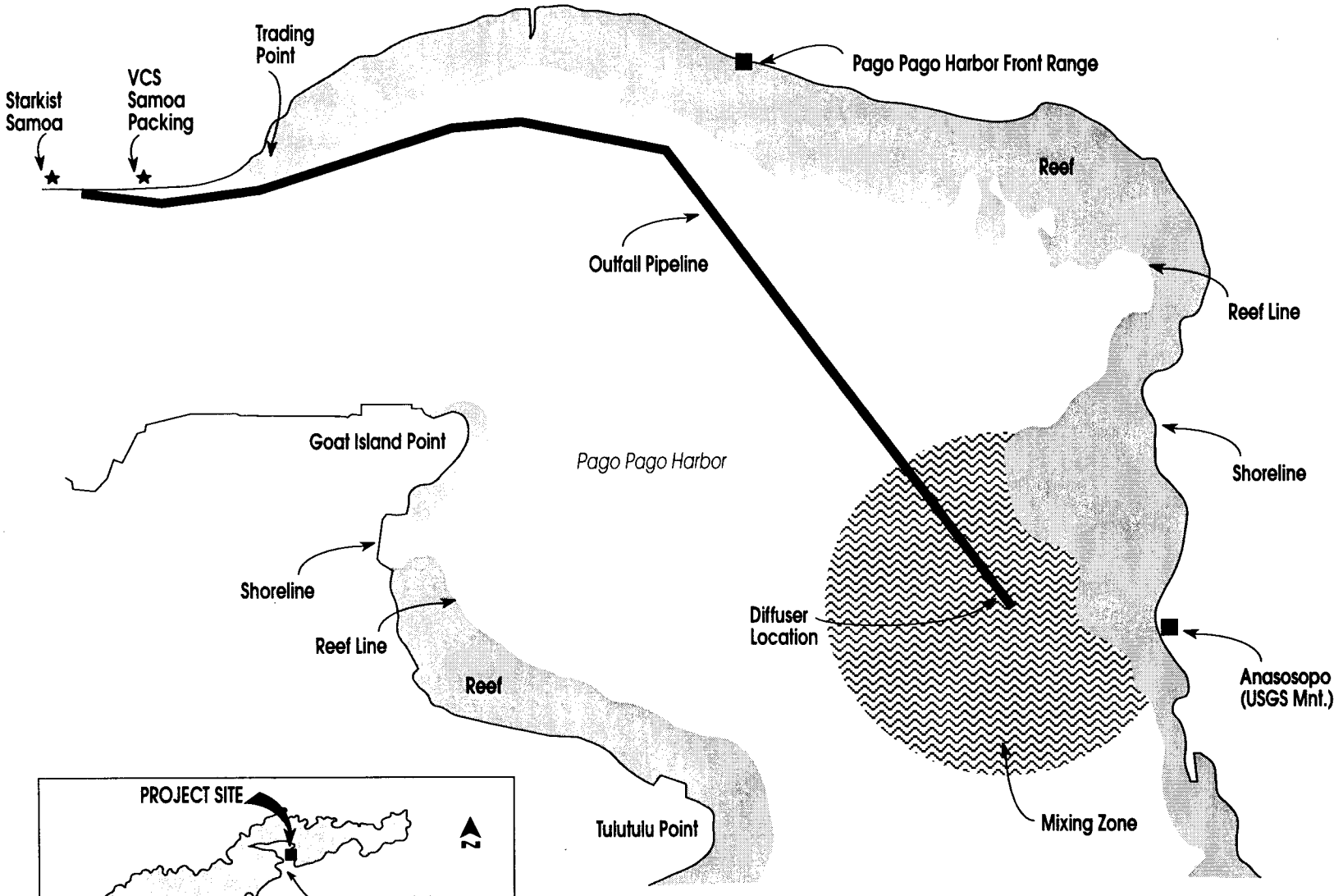

FIGURE 1-1
Location of Joint Cannery Outfall, Diffuser, and Zone of Mixing in Pago Pago Harbor

PDX30702.RS.R1 / Starkist Samoa / Fig. 1-1 Loc. of Joint / 6-24-93 / LKW

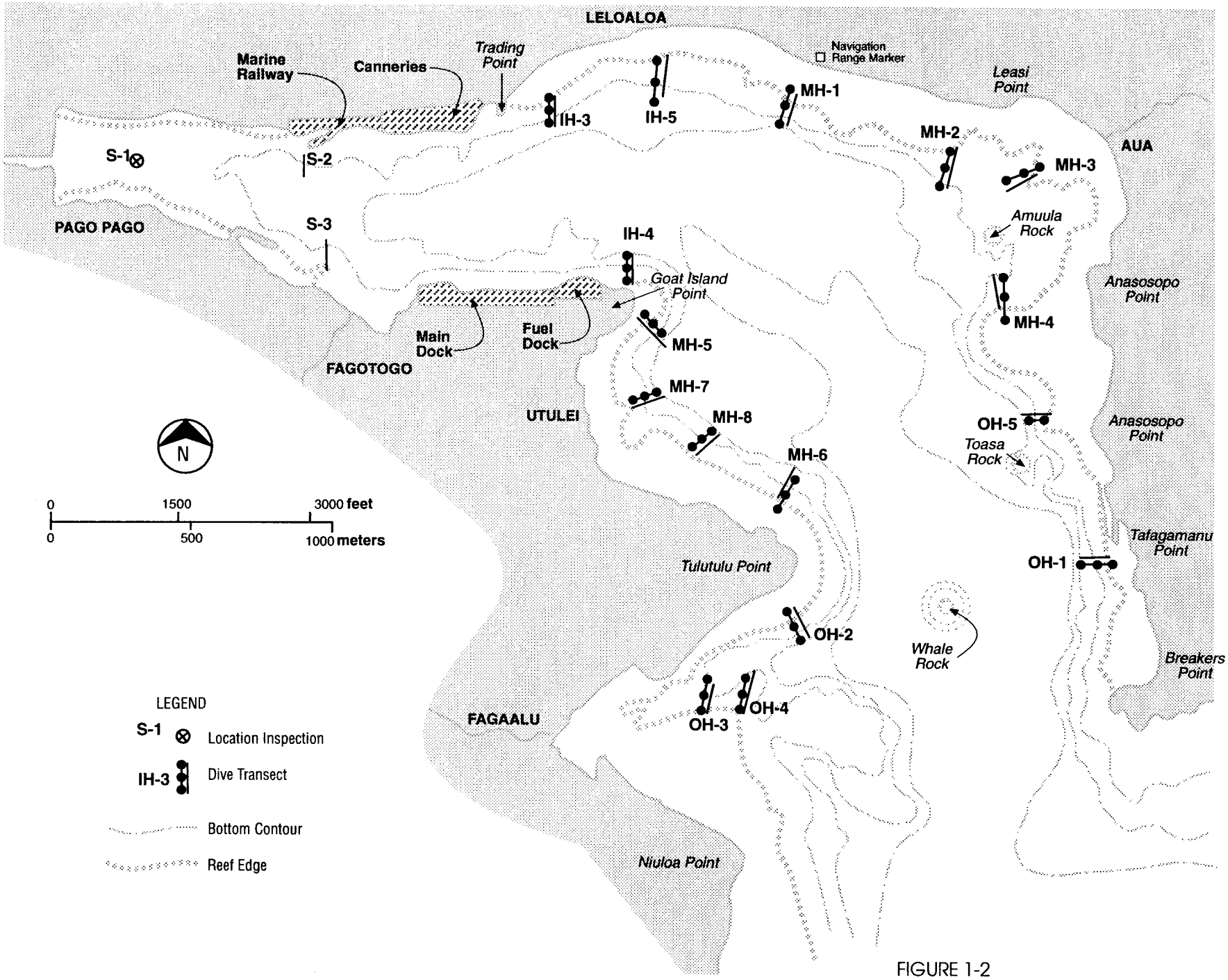

FIGURE 1-2
Location of Coral Reef Transects in Pago Pago Harbor

condition of and changes to the reef-face habitat in areas of the inner, middle, and outer Pago Pago harbor. The surveys are limited to providing semi-quantitative data on the type, percent cover of live reef corals and other benthic species. Reef fish identifications are incidental to the reef habitat evaluation.

The video transect records were analyzed and summarized by Mr. Troy Buckley of the University of Washington School of Fisheries. Mr. Buckley is a qualified marine ecologist with knowledge of tropical reef taxonomy and several years of experience specifically in American Samoa. He also analyzed the 1991 survey videos. Estimates were developed of live coral coverage and specific benthic genera identifications were provided, as feasible from the video record. Field survey data are presented in tabular formats in the results section of this report. Supporting data are included in the report appendix. Copies of the video records are provided to ASEPA and USEPA as separate attachments to this report.

STUDY SITE DESCRIPTION

The *American Samoa Coral Reef Inventory* (published by the U.S. Army Corps of Engineers in 1981), reports that the fringing coral reefs in Pago Pago Harbor have been extensively modified, primarily by the U.S. Navy and American Samoan Government. Dredging, filling, construction of rock seawall and other structures for roadway slope stabilization, and other construction activities have resulted in physical alterations to the coral reefs. These activities began around 1900. The most dramatic changes occurred during World War II and since 1960. The Coral Reef Inventory reports that approximately 23-percent of the original reef flat area in Pago Pago Harbor has been filled.

The inner harbor area has been the most affected by development activities. According to the Coral Reef Inventory, 95 percent of the original reef in the Inner Harbor has been converted to dry land. Some remnant reef is found in the Inner Harbor area but living corals have been absent from the Inner Harbor for many years. This conclusion, presented in the Coral Reef Inventory, was drawn from a 1977 study.

Substantial physical alterations to the reef in the Middle and Outer Harbor include the following as presented in the Coral Reef Inventory:

- The reef flat off the Rainmaker Hotel and Utulei Beach has been dredged to provide sandy areas for swimming and access across the reef.

- Near Aua Point, a borrow pit 18 feet deep was dredged to obtain roadbed fill material, creating a large lagoon inside the inner reef.

- The shoreline north of Tafagamanu Point was extended 300 feet onto the reef flat by filling for a sanitary landfill.

- An extensive fill area along the south Fagaalu Bay was developed for a public park from material dredged from the reef flat.

- The discharge of sediments from the streams draining into the harbor has led to extensive siltation over large portions of the reef near the mouths of these streams (described in detail below).

The coral reefs of Samoa have been subjected to periodic infestations or population explosions of the coral-feeding crown-of-thorns starfish (*Acanthaster planci*). The 1981 Coral Reef Inventory reports serious crown-of-thorns infestations on the reefs of Tutuila Island in the 1920s and most recently in the late 1970s and early 1980s. These periodic infestations have greatly reduced the live coral assemblages on the fringing reefs. Destruction of the live coral assemblages has been shown to vary widely, but, as described in the Coral Reef Inventory, roughly 50 to 95 percent of live coral were estimated to have been destroyed by the 1970-80 starfish infestation.

Recent dive surveys of the coral reefs in the Fagatele Bay Marine Sanctuary have shown live coral coverages of approximately 50 percent after nearly complete destruction by the crown-of-thorns starfish. The fringing reefs of middle and outer Pago Pago Harbor were also substantially damaged by the crown-of-thorns infestation. The starfish were observed on the reefs off Aua (in middle harbor) and of Fagaalu (outer harbor) during 1980 when the Coral Reef Inventory was conducted. Reef recovery from these infestations is slow, and the existing live coral coverages on the fringing reefs of Tutuila Island still show large areas of dead coral.

Periodic hurricanes pass near or directly over Tutuila Island, and these storms generate large waves. Waves approaching from the south enter the outer and middle harbor and break on fringing reef, damaging the reef habitat either directly or by disturbing sediments that are deposited on the reefs. Recent intense hurricanes, particularly Huricane Fay, have had significant impacts on the fringing reefs in Pago Pago Harbor through wave impacts, siltation, and longline vessels grounded on the reefs. In addition, much of the road bed abutting the reef flat is unprotected from erosion through riprap cover or other stabilization techniques, leading to extensive siltation of some areas of the reef flats.

Section 2

FIELD SURVEY METHODS

This section describes the methods and equipment used for the coral reef surveys, including horizontal positioning at each reef site, sampling methods, and QA/QC procedures. Field equipment requirements for the reef surveys are listed in Table 2-1. A small work vessel was used for the surveys. A three-person staff was aboard to conduct the reef survey transects.

Table 2-1
Field Equipment for Coral Reef Surveys

Equipment Item	Purpose	Number of Units
Work Vessel	Field Sampling Platform	1
SCUBA diving equipment and tanks	Underwater surveys	3
ScubaPro Monitor II Dive Computer	Continuous dive logging for each diver's repetitive dives and surface intervals (safety equipment)	2
Sony 8mm Videocamera w/ underwater housing and lights	Underwater videotaping of reef transects	2
Sony 8mm Videotape player	Viewing and verification of videotape records	1
Nikonos Camera	Underwater still photographs	1
30-meter transect line	Provide reference line for video transects	2
Transect Stakes	Establish start and end point for each transect	100
SeaKing Recording Fathometer	Record reef profile at each site	1
Motorola Mini-Ranger III System	Microwave positioning System with 3 shore-based transponders	1

SURVEY SITES AND FIELD POSITIONING

Nineteen reef sites were surveyed as shown on Figure 1-2. Transects were conducted at multiple depths at 16 of these sites. Only a single transect was conducted from the top to the base of the reef at the three sites located in the western end of the inner harbor (S-1, S-2, and S-3 on Figure 1-2). The nineteen reef survey sites were located based on the descriptions in the 1991 Use Attainability Analysis reef survey logbook and photographs of the reef and shoreline at each site. A marker buoy was set to mark each site. To facilitate location and reoccupation of the transects during future surveys required under the NPDES permit conditions, the horizontal position of each site was recorded using a Motorola Mini-Ranger III electronic positioning system. The Mini-Ranger III provides positioning range accuracy of approximately ±2 meters. A bathymetric profile of the reef front was also made using a recording fathometer further to document each site. The Mini-Ranger locations of each site and the site descriptions are given in Table 2-2 for the inner harbor, Table 2-3 for the middle harbor, and Table 2-4 for the outer harbor.

At each of the nineteen sites, transect marker stakes were driven into the reef at the start of each transect. These stakes are designed to provide a long-term reference point for each transect line along the reef-face. In 1995 and 1997, if the transect marker stakes cannot be located by visual positioning, then the Mini-Ranger coordinates can be used to locate a site and a buoy will be deployed to assist divers to search for the stakes.

REEF TRANSECT METHODS

Marine biologist-divers recorded underwater video transects on the reef front at 19 sites in Pago Pago Harbor (Figure 1-2). At 16 sites (IH-3, 4, 5, MH-1 through 8, and OH-1 through 5), video transects were recorded along the reef face at three depths. The three sites located in the western end of the inner harbor (S-1, S-2, and S-3) are remnants of reefs with less than 5 percent live coral, and only a single transect was recorded from the reef flat down to the base of the reef face.

Each video transect, with the exceptions mentioned above, was conducted parallel with the reef face (along a depth contour) along a 30-meter fixed transect line on the reef. The depths at which video transects were recorded included: the reef edge (15- to 20-foot depth), on the reef face (at 30- to 40-foot depth), and near the base of the reef face (at 55- to 65-foot depth). The reef front at some sites (e.g. MH-3) does not extend below 45 feet, and only two transects were be conducted at similar sites. Video records of the reef flat areas were also recorded at six representative sites (IH-3, MH-3, MH-8, OH-3, and OH-5) to document reef flat conditions.

Table 2-2
Inner Harbor Transect Locations for Coral Reef Survey Pago Pago Harbor
February 1993 Survey

Station	Sampling Location and Depth (feet)	Navigation Coordinates for MiniRanger System (a,b)	
		Code 1	Code 4
S-1	Inner Harbor, approx. 1,000 feet east of mouth of Pago Pago Stream, at 20- to 50-foot depth	2468 (N)	1584 (N)
S-2	Inner Harbor, immediately in front of Marine Railway facility, at 15- to 50-foot depth	1833 (N)	1050 (N)
S-3	Inner Harbor, in front of Marine Resources Building at Fagotogo, at 10- to 65-foot depth	1899 (N)	783 (N)
IH-3	Inner Harbor, approx. 200 feet east of Trading Point, Transects at 25, 40, and 60 feet	1033 (N)	833 (N)
IH-4	Inner Harbor, located on north side of Goat Island Point, Transects at 25, 40, and 60 feet	1016 (N)	383 (N)
IH-5	Inner Harbor, located off Leloaloa and 1,600 feet east of Trading Point, Transects at 20 and 35 feet	601 (N)	1085 (N)

NOTES:

(a) The shore-based Mini-Ranger transponders were located at survey control points as follows: Code 1 - located at Pago Pago Harbor Front Range Tower (261,551.58E and 309,857.04N, State Coordinates (feet)); Code 4 - located at Fagatogo Tram Park Building (258,117.06E and 305,879.24N, State Coordinates (feet)).

(b) The navigation readings are designated as either north (N) or south (S) of the alignment between the Code 1 and Code 4 shore transponder stations. NR indicates no readings were recorded due to the transponder station being obstructed.

At each of the nineteen sites, two divers descended to the three designated transect depths and installed 3-foot PVC marker stakes into the reef to mark the transect starting location. These transect marker stakes were driven into the reef at the start and end of each transect line to provide a long-term reference point for each transect line along the reef-face. After each marker stake was established, the divers were at the deepest transect and they then commence the deep transect surveys.

One diver maintained position at the deep transect stake location and handled a 30-meter transect line marked every 2.5 meters. The other diver swam slowly along the established 30-meter transect line with the video camera and recorded two passes on the line, and installed the end transect marker stake. The diver initially stationed at the starting position took still photographs along the transect line using a 35mm camera. At

Table 2-3
Middle Harbor Transect Locations for Coral Reef Survey Pago Pago Harbor
February 1993 Survey

Station	Sampling Location and Depth (feet)	Navigation Coordinates for MiniRanger System (a,b)	
		Code 1	Code 4
MH-1	Middle Harbor, located off Harbor front range marker (Code 1), Transects at 25, 40, and 60 feet	216 (S)	1198 (S)
MH-2	Middle Harbor, located off Leasi Point, Transects at 25, 40, and 60 feet	533 (S)	1582 (S)
MH-3	Middle Harbor, located west of Aua and north of Amuula Rock, Transects at 20 and 35 feet	750 (S)	1798 (S)
MH-4	Middle Harbor, located on north face of reef and west of Aua Point, Transects at 25, 40, and 60 feet	1082 (S)	1649 (S)
MH-5	Middle Harbor, located on south face of reef at Goat Island Point, Transects at 25, 40, and 60 feet	1116 (S)	400 (S)
MH-6	Middle Harbor, located on northeast face of reef off Tulutulu Point, Transects at 25, 40, and 60 feet	1550 (S)	1052 (S)
MH-7	Middle Harbor, located on east face of reef off Utulei, Transects at 25, 40, and 60 feet	1349 (S)	399 (S)
MH-8	Middle Harbor, located on east face of reef off Utulei tank farm, Transects at 25, 40, and 60 feet	1449 (S)	683 (S)

NOTES:

(a) The shore-based Mini-Ranger transponders were located at survey control points as follows: Code 1 - located at Pago Pago Harbor Front Range Tower (261,551.58E and 309,857.04N, State Coordinates (feet)); Code 4 - located at Fagatogo Tram Park Building (258,117.06E and 305,879.24N, State Coordinates (feet)).

(b) The navigation readings are designated as either north (N) or south (S) of the alignment between the Code 1 and Code 4 shore transponder stations. NR indicates no readings were recorded due to the transponder station being obstructed.

the completion of the transect filming, the transect line was picked up and moved to the next transect depth and the procedure was be repeated.

A field logbook was maintained and included: the sampling times, descriptions of the site, transect depths, reef face structure and features, reef biota observations, and weather and sea conditions. The videotape was reviewed at the completion of each day

in the field to ensure that the record is complete and to record the location of each transect record on the video tape.

Table 2-4
Outer Harbor Transect Locations for Coral Reef Survey Pago Pago Harbor
February 1993 Survey

Station	Sampling Location and Depth (feet)	Navigation Coordinates for MiniRanger System (a,b)	
		Code 1	Code 4
OH-1	Outer Harbor, located on west face of reef off Tafagamanu Point, Transects at 25, 40, and 60 feet	2033 (S)	2166 (S)
OH-2	Outer Harbor, located on south face of reef south of Tulutulu Point, Transects at 25, 40, and 60 feet	2016 (S)	NR
OH-3	Outer Harbor, located on north face of reef, north of Niuloa Point, Transects at 25 and 40 feet	NR	NR
OH-4	Outer Harbor, located on north face of reef, north of Niuloa Point, Transects at 25, 40, and 55 feet	NR	NR
OH-5	Outer Harbor, located on west face of reef off Anasosopo Point, Transects at 25, 40, and 60 feet	1466 (S)	1799 (S)

NOTES:

(a) The shore-based Mini-Ranger transponders were located at survey control points as follows: Code 1 - located at Pago Pago Harbor Front Range Tower (261,551.58E and 309,857.04N, State Coordinates (feet)); Code 4 - located at Fagatogo Tram Park Building (258,117.06E and 305,879.24N, State Coordinates (feet)).

(b) The navigation readings are designated as either north (N) or south (S) of the alignment between the Code 1 and Code 4 shore transponder stations. NR indicates no readings were recorded due to the transponder station being obstructed.

QUALITY ASSURANCE AND QUALITY CONTROL

The quality assurance and quality control objectives for the coral reef surveys are to record representative reef-front transects at each site and provide scientific interpretations and summaries of these reef transect videos that are of known and acceptable quality. The following requirements were instituted for the filed data collection to meet the objectives.

- Establish long-term transect markers and document survey site positions (within 2 meters) for repeat surveys.

- Provide field equipment redundancy (backup equipment).

- Develop a field operations and safety plan for conducting the reef surveys to summarize the schedule, survey procedures, field data recording, and safety procedures. This operations and safety plan is a key element of quality assurance and control activities.

- Test all dive and photographic equipment onsite prior to the beginning of the surveys and conduct daily equipment checks.

In addition, the data analysis, described below, was accomplished in a fashion to provide verifiable photographic interpretations of the reef transect videos with QA procedures to estimate accuracy and error. Ten percent of all video transects were reanalyzed without coral identification to verify that transcription accuracy and error estimates are acceptable.

Section 3

DATA ANALYSIS AND PRESENTATION OF RESULTS

The field surveys of the fringing coral reef in Pago Pago Harbor were conducted February 7th through 13th, 1993. The coral reef surveys will be used to evaluate the condition of, and changes to, the reef-face habitat in areas of the inner, middle, and outer Pago Pago harbor. These surveys are limited to providing semi-quantitative data on the type, percent cover of live reef corals and other benthic species. The intent of the surveys is to provide information necessary to generally characterize and document changes to the reef habitat. It is not intended that the data be used to quantitatively describe details of the reef habitat or communities. The surveys are targeted at examination of the benthic substrate and species. Reef fish identifications are not an objective of the study.

ANALYSIS OF VIDEO TAPES

The videotape transect records were analyzed and summarized by a qualified marine ecologist with tropical reef knowledge and several years of experience specifically in American Samoa. The videotape analysis involves repeated slow-frame viewing of the transect video to record estimates of live coral coverage and specific benthic genera. The percent of live coral was estimated at 5 meter intervals along the transect line, for 2.5 meter segments. Benthic genera identifications were made, as feasible, from the video record. Field survey data was then summarized from notes made during the video transect viewing.

Using mobile species like fish to assess ecological impacts or habitat quality on a relatively small scale is not feasible without conducting the survey over a long period of time. Many environmental and behavioral factors (season, lunar phase, time of day, tide, weather patterns, etc.) may influence the abundance of fish species in a given area at a given time. Using the sessile benthic community (primarily scleractinian corals) and habitat complexity and structure to assess the prevailing or average ecological condition introduces the least amount of bias due to immediate conditions and diver avoidance.

Data collection with video tapes of prescribed areas, or transects, reduces the limitation of SCUBA diver bottom time. However, some detail will be lost and some bias will be introduced by the camera and the camera operator. Use of video transects in this case reduced the ability to detect and distinguish between encrusting corals, coralline algae, sponges and other organisms. Camera operator bias can be introduced in several ways; travelling speed and distance from bottom, camera angle, straying from transect, recognition of organisms requiring closer focus to be identified by the video tape reviewer, and in some cases, not providing scale with the transect line as a reference.

Transcription of the video tape required rough identifications, and rough estimations of sizes and percentage of areal coverage. Coral identification is only provided to the generic level. Levels of uncertainty vary and depend on colony size and shape and the uniqueness of the colony form to certain genera (for example *Echinopora* and *Montipora* are easily confused by video inspection). Distance, angle and form of the colony can cause errors in estimating size and areal coverage. This is compounded by the inability to distinguish between encrusting organisms.

Although there are biases unavoidably introduced in a survey such as the one reported here, gross identification of the larger benthic organisms, including corals, and a general characterization of the habitat structure and complexity were achieved. Biological interpretations and projections of the results are difficult, and are especially vulnerable to an individual's predicated bias. However, for the purpose of detecting general habitat changes over long time periods the techniques used in this survey are acceptable and adequate to achieve the objectives of the NPDES permit condition.

REEF SURVEY RESULTS

The transect analyses notes are presented in Appendix A. Tables 3-1, 3-2a, 3-2b, and 3-3 summarize the semi-quantitative survey results. These summary tables provide the station characteristics, benthic or sessile organisms coverage, and hard coral coverage for each transect. Inner harbor transects S-1, S-2, S-3, IH-3, IH-4, and IH-5 are summarized in Table 3-1. Middle harbor transects MH-1, MH-2, MH-3, and MH-4 are summarized in Table 3-2a. Middle harbor transects MH-5, MH-6, MH-7, and MH-8 are summarized in Table 3-2b. Outer harbor transects OH-1, OH-2, OH-3, OH-4, and OH-5 are provided in Table 3-3. Copies of the video records were provided to ASEPA and USEPA as a separate attachment to this report.

Inner Harbor. The existing or remnant coral reef areas in the inner harbor are very limited as a result of shoreline filling and pier construction. Three transect stations were established in the western end of the inner harbor (S-1, -2, and -3) at known remnant coral reefs or coral heads. These three transect locations consisted of soft substrates and silt-covered remnant coral heads and coral rubble. No live corals or other hard-substrate organisms were present. Several fishes were identified near the base of the remnant coral reef along portions of transect S-3.

Table 3-1. Results of February 1993 Coral Reef Surveys: Inner Harbor Transects

Station	S1	S2	S3	IH3				IH4			IH5		
Station Characteristics													
Depth (ft)	15-40	15-60	10-65	2-5	25	40	60	25	40	60	20	35	50
Percent Sand, Sediment & Rubble	100	100	95	56	99	98	97	90	95	99	5	95	90
Slope Description	G	FS	G/S	F*	FS	S	G	W	W	S	FS	FS	G
Sessile Organisms (percent coverage)													
Algae				20				<1			1		5
Coralline algae			<5	20P				P	P		50P	2	
Sponges			<5		1	2	3	<5	<5	<1	5	2	
Hydroids													5
Stylaster (hydrocorallina)													
Millepora (hydrocorallina)													
Zoanthids													
Soft Coral								<1					
Hard Coral (percent coverage)													
Pocillopora													
Montipora									1		P		
Acropora													
Fungia												1	
Herpolitha													
Porites											P		
Faviidae											1		
Diploastrea heliopora								5	<5				
Echinopora													
Galaxea													
Lobophyllia													
Unidentified Encrusting Forms				<5P									
Unidentified Digitate Coral													
Total Percent Live Hard Coral	0	0	0	<5	0	0	0	5	<6	0	<5	1	0
Total Number of Hard Coral Genera	0	0	0	0	0	0	0	1	2	0	3	1	0
Total Hard Coral Genera per Station	0	0	0	0				2			4		

F* = Transect conducted on reef flat area
P = present (approximate coverage estimated)
G = Gradual
FS = Fairly Steep
W = Vertical Reef Wall
S = Steep
F = Flat
T = Terraced

Table 3-2a. Results of February 1993 Coral Reef Surveys: Middle Harbor Transects

Station	MH1			MH2			MH3			MH4			
Station Characteristics													
Depth (ft)	25	40	60	25	40	60	2-5	20	35	2-5	25	40	60
Percent Sand, Sediment & Rubble	10	25	35	30	35	65	5	25	75	0	40	50	97
Slope Description	G	FS	FS	G	FS	FS	F*	G	G	F*	T/S	T/S	G
Sessile Organisms (percent coverage)													
Algae	5								<5				
Coralline algae	43	35	30	20	20	20	60	<5		80	10	5	
Sponges	7	5	5	5	1	<5		1	1	1	5	3	2
Hydroids													
Stylaster (hydrocorallina)													
Millepora (hydrocorallina)					1								
Zoanthids		1						15	10		15	10	1
Soft Coral							2	5		8	10	2	
Hard Coral (percent coverage)													
Pocillopora							5			3			
Montipora		1			20	P	5			2			
Acropora							5						
Fungia		<1			1	1							
Herpolitha													
Porites	10				P		7			5			
Faviidae													
Diploastrea heliopora	5	5		30				50	9		15	27	
Echinopora						10							
Galaxea		<1			2								
Lobophyllia					20	1			1				
Unidentified Encrusting Forms	5	1	<5	15			7	1			5	3	
Unidentified Digitate Coral						1							
Total Percent Live Hard Coral	20	<9	<5	45	43	13	29	51	10	10	20	30	0
Total Number of Hard Coral Genera	2	4	0	1	5	4	4	1	2	3	1	1	0
Total Hard Coral Genera per Station	5			7			6			4			

F* = Transect conducted on reef flat area
P = present (approximate coverage estimated)
G = Gradual
FS = Fairly Steep
W = Vertical Reef Wall
S = Steep
F = Flat
T = Terraced

Table 3-2b. Results of February 1993 Coral Reef Surveys: Middle Harbor Transects

Station	MH5			MH6			MH7			MH8			
Station Characteristics													
Depth (ft)	25	40	60	25	40	60	25	40	60	2-5	25	40	60
Percent Sand, Sediment & Rubble	5	25	75	50	30	75	90	75	90	10	20	75	90
Slope Description	W	W	G	S	G	G	T/G	T/G	D	F*	S	S	G
Sessile Organisms (percent coverage)													
Algae											1		
Coralline algae	60	30	10P	20P	5P					75	70	10P	2P
Sponges	5	10	5	10	5	5	1	2	2		5	5	3
Hydroids													
Stylaster (hydrocorallina)		1											
Millepora (hydrocorallina)											1		
Zoanthids									2				
Soft Coral	3						5		1				
Hard Coral (percent coverage)													
Pocillopora					<1					4			
Montipora		5		4	10	3		P	P				
Acropora	2			1	3								
Fungia											1		
Herpolitha												1	
Porites								1		3			1
Faviidae						1							2
Diploastrea heliopora	20	5	1		45	15	3	15	1			5	
Echinopora				2				P	P				
Galaxea													
Lobophyllia					1	1							
Unidentified Encrusting Forms	5			4			1	2	2	3	2P	4P	2P
Unidentified Digitate Coral									1				
Total Percent Live Hard Coral	27	10	1	11	60	20	4	18	4	10	3	10	5
Total Number of Hard Coral Genera	2	2	1	3	5	4	1	4	3	2	1	2	2
Total Hard Coral Genera per Station	3			7			4			6			

F* = Transect conducted on reef flat area
P = present (approximate coverage estimated)
G = Gradual
FS = Fairly Steep
W = Vertical Reef Wall
S = Steep
F = Flat
T = Terraced

Table 3-3. Results of February 1993 Coral Reef Surveys: Outer Harbor Transects

Station	OH1			OH2			OH3		OH4				OH5		
Station Characteristics															
Depth (ft)	25	40	60	25	40	60	25	40	2-5	25	40	60	25	40	60
Percent Sand, Sediment & Rubble	10	35	75	0	0	20	32	42	0	5	30	50	<5	<5	70
Slope Description	W	W	FS	T/FS	T/FS	T/FS	T/G	G/F	F*	T/W	S	G	W	FS	FS
Sessile Organisms (percent coverage)															
Algae						1								2	
Coralline algae	50	45	10	20	20	15	<1	20	40	20	40	10	80	80	20
Sponges	10	10	10	2	5	2	<1	1		5	10	1	10	5	<5
Hydroids										5	<5	25			
Stylaster (hydrocorallina)	3	3	1							1	1				
Millepora (hydrocorallina)												1			
Zoanthids															
Soft Coral				10	15	1	2		5						
Hard Coral (percent coverage)															
Pocillopora				1			<1		25	1					
Montipora	20	5		5	5	13		1		25			P	1	
Acropora				10		1	5	5	10	1		1		1	
Fungia						2								2	2
Herpolitha						1									2
Porites	P				3		50	10		2		1	P	1	
Faviidae	1			5	4	1		<1							
Diploastrea heliopora	5			15		5					5				
Echinopora				P	10	35				5P	5	1			
Galaxea		2			1	1									
Lobophyllia	1			3	1						<1				
Unidentified Encrusting Forms			<5	25	30				10		2		5P	2	
Unidentified Digitate Coral				4	1	2					2	5			
Total Percent Live Hard Coral	27	7	<5	68	55	61	<56	<17	45	34	<15	8	5	7	4
Total Number of Hard Coral Genera	5	2	0	7	6	8	3	4	2	5	3	3	2	4	2
Total Hard Coral Genera per Station	6			11			5		7				5		

F* = Transect conducted on reef flat area
P = present (approximate coverage estimated)
G = Gradual
FS = Fairly Steep
W = Vertical Reef Wall
S = Steep
F = Flat
T = Terraced

Three stations were surveyed in the transition area from the inner to middle harbor (IH-3, -4, and -5). Sediments were observed to cover substantial areas of hard substrates at all depths. Stations IH-3 and IH-5, located along the reef face between Trading Point (immediately east of the cannery docks) and the rock jetty at Leloaloa, had less than 5-percent live coral at all depths. The reef front at these two stations consisted of steep, silt-covered, rubble slopes. Station IH-4, located 200 feet east of the fuel dock and on the north face of the basalt outcrop at Goat Island Point, had less than 6-percent live coral at all depths. Coraline algae and sponges were primarily observed at IH-4. These 1993 survey results are identical to the 1991 reef survey findings.

Middle Harbor. The middle harbor region of Pago Pago Harbor extends approximately from Leloaloa to Aua Point on the northern and eastern shoreline, and from Goat Island Point to Tulutulu Point along the western shoreline. The middle harbor region includes areas of direct wave impacts along the northern shoreline, and two semi-enclosed embayments (off the villages of Utulei and Aua). Eight stations were located to represent the range of reef exposures around the middle harbor. Stations MH-1 and MH-2, were located along the northern shore that receives direct wave impacts from the south. The transects conducted at these two stations had 20- to 45-percent live coral at the 25-foot transect depth, and 9- to 43-percent live coral at the 40-foot depth transects.

The 60-foot transects at MH-1 and -2 had only 9- to 13-percent live coral and 35- to 65-percent sand/silt or rubble coverage. The 25- and 40-foot transects at these two stations showed 10 to 35 percent sand/silts and rubble coverage, which represents a substantial increase over the 1991 values (<1-percent). This increase in sands/silts and rubble coverage is believed to be due to the severe impacts of Tropical Cyclone Val in December 1991 (Tropical Cyclones Ofa in February of 1990 and Lin in February of 1993 are other recent major storms affecting American Samoa). Evidence of the hurricane wave forces is exhibited by the six longline vessels that are grounded on the reef flats between Leloaloa (site of IH-5) and the harbor navigation range marker (site of MH-1).

The results of the reef surveys at MH-3 and MH-4, located inside the semi-enclosed embayment between Leasi Point and Aua Point, show moderately diverse coral representation and zoanthid colonies were the dominant benthic organism. The 25- and 35-/40-foot transects at these stations had 20- to 51-percent live coral, compared to 5 to 50% live coral recorded in the 1991 survey. Both stations MH-3 and MH-4 showed some siltation of flat surfaces, probably due to sediments released from the stream at Aua and from resuspended bottom sediments in the embayment. Some indication of wave impact damages were observed in the shallow (<20 feet) depths near the fringing reef at MH-3.

Four stations (MH-5, -6, -7, and -8) were located along the western shoreline of the middle harbor, and these reef areas have established hard and soft corals communities. The 25- and 40-foot transects at MH-5 and -6, located at more wave-exposed sites, had

10- to 60-percent live coral and 5- to 50-percent sand/silt or rubble coverage. In comparison, the 25- and 40-foot transects at MH-7 and -8 showed 10- to 18-percent live coral coverage and 20- to 75-percent sand/silts and rubble coverage. MH-7 and MH-8 are located in a semi-enclosed embayment and clearly show siltation resulting from Vailoa stream discharges and sediments resuspended in the excavated reef flat between the Pago Pago Yacht Club and the park. The number of coral genera observed in this 1993 survey was equivalent to the 1991 survey results at these middle harbor stations.

Outer Harbor. The outer harbor region extends from Tulutulu Point to Niuloa Point on the western shoreline, and from Anasosopo Point to Breakers Point on the eastern shoreline. Five stations were located in the outer harbor, two along the eastern shoreline (OH-1 and OH-5), and three on the western shoreline. The two east shoreline stations and OH-2 on the south face of Tulutulu Point are all directly wave-exposed sites. The steep reef face structure, percentages of live corals, silt coverage, and benthic diversity observed at stations OH-1 is very similar to the reef face conditions at MH-5, located on the south face of Goat Island Point.

Transect conducted at 25- and 40-feet at Station OH-5 consists primarily of a steep slope of staghorn coral (*Acropora)* rubble with coralline algae and sponges on the rubble. This reef face shows indications of typical wave damage down to 50 feet depth, and the sand/silt coverage at these two transect depths was less than 5-percent. At the 60-foot depth transect the reef face changes to mostly sand and silt with few coral outcroppings. Station OH-5 is also located approximately 600 feet from the new joint cannery outfall diffuser. No evidence of the wastewater impacts or settleable solids was observed at this station.

Stations OH-3 and OH-4, located on a north-face in the semi-enclosed embayment off Fagaalu, had live coral coverages of 34- to 56-percent at 25 feet and only 15- to 17-percent at 40 feet depth. The observed live coral and sessile organism diversity at stations OH-3 and OH-4 were comparable to the middle harbor stations, and may be influenced by the siltation from Fagaalu Stream. Station OH-2, located in a wave-exposed area yielded the highest diversity and coverage of hard corals, with 55- to 68-percent live coral coverage for all three transect depths.

DISCUSSION OF RESULTS

This report presents the results of the baseline coral reef survey conducted to monitor possible changes in reef conditions following relocation of the canneries discharge points and the implementation of high strength waste segregation. These coral reef field surveys were also designed and conducted to allow comparisons of the reef conditions between areas of the inner, middle, and outer Pago Pago harbor. Comparisons between

regions in the harbor and between the semi-annual surveys will be made to characterize and document any changes.

A general qualitative comparison can be made between this survey and the previous survey done by CH2M HILL in 1991. The results of the 1991 survey have been extracted from the Use Attainability Report and are present in Appendix B. The results of this comparison include the following:

- The inner harbor seabed consists of silty muds and areas of silt covered remnant coral structures. The remnant reef fronts surveyed in the western half of the inner harbor do not appear to sustain live hard or soft corals. There are no apparent changes to the seabed conditions in the inner harbor between the 1991 and 1993 surveys.

- The north-shore reef face between Trading Point and Leloaloa represents a transition zone from the heavily silted inner harbor to the middle harbor region. In this transition zone, less than 5-percent live hard coral was recorded in 1991 and 1993.

- The middle harbor region includes a wide range of exposed and protected reef areas. The 1991 and 1993 surveys both show live coral coverages ranged from 1- to 60-percent, with an average of 20-percent for all transect depths. Station MH-1 showed clear indications of wave impact damages to the reef face, with greater rubble coverage and broken coral heads. In the middle harbor area, stations MH-2 and MH-6 show the greatest live hard coral coverage for the 1993 survey. Essentially all middle harbor reef areas showed substantially increased sand and silt coverage of surfaces in the 1993 survey, in comparison to the 1991 survey.

- The outer harbor region includes a range of exposed and protected reef areas. The 1993 survey showed live coral coverage ranged from 5-percent (depth average) at OH-5 to 61-percent (depth averaged) at OH-2. In the 1991 survey, live coral coverage ranged 7-percent (depth average) at OH-5 to 38-percent (depth averaged) at OH-3.

- The live hard coral coverages and diversity at the middle harbor reef faces are generally comparable to the outer harbor reef areas, with the exception of Station OH-2. Reef transect stations located near stream discharges in both the middle and outer harbor regions showed siltation effects, including reduced live hard coral coverage and diversity.

Tables 3-4, 3-5, and 3-6 summarize the results of the two studies in terms of number of hard coral genera identified at each station and the depth averaged percent coverage of hard corals. Differences in details such as variability with depth, actual numbers and

extent of various genera, and other station characteristics can be found by comparing Tables 3-1,3-2a and b, and 3-3 with Tables B-1. B-2a and b, and B-3 in Appendix B.

Table 3-4
Summary Results of 1991 and 1993 Coral Reef Surveys
for Inner Harbor Stations

STATION	S1	S2	S3	IH3 (1)	IH4	IH5 (2)
February 1993 Survey						
Total Percent Live Hard Coral Coverage (depth average)	0	0	0	0	4	3
Total Number of Live Hard Coral Gernera Identified per Station (all depths)	0	0	0	0	2	4
January 1991 Survey						
Total Percent Live Hard Coral Coverage (depth average)	0	0	0	0	3	2
Total Number of Live Hard Coral Gernera Identified per Station (all depths)	0	0	0	0	2	3

(1) Reef flat data excluded from 1993 data to make data bases comparable.
(2) 50-foot data excluded from 1993 data to make data bases comparable.

Table 3-5
Summary Results of 1991 and 1993 Coral Reef Surveys
for Middle Harbor Stations

STATION	MH1	MH2	MH3	MH4	MH5 (1)	MH6	MH7 (1)	MH8
February 1993 Survey								
Total Percent Live Hard Coral Coverage (depth average)	11	34	30	15	13	30	9	7
Total Number of Live Hard Coral Gernera Identified per Station (all depths)	5	7	6	4	3	7	4	6
January 1991 Survey								
Total Percent Live Hard Coral Coverage (depth average)	13	22	10	20	27	27	12	9
Total Number of Live Hard Coral Gernera Identified per Station (all depths)	4	8	9	7	3	7	3	5

(1) Reef flat data excluded from 1991 data to make data bases comparable.

Table 3-6
Summary Results of 1991 and 1993 Coral Reef Surveys
for Outer Harbor Stations

STATION	OH1	OH2 (1)	OH3 (2)	OH4 (3)	OH5 (4)
February 1993 Survey					
Total Percent Live Hard Coral Coverage (depth average)	13	62	37	18	6
Total Number of Live Hard Coral Gernera Identified per Station (all depths)	6	9	5	7	4
January 1991 Survey					
Total Percent Live Hard Coral Coverage (depth average)	8	23	38	25	8
Total Number of Live Hard Coral Gernera Identified per Station (all depths)	4	10	3	14	7

(1) 60-foot data excluded from 1993 data to make data bases comparable.
(2) Reef flat data excluded from 1991 data to make data bases comparable.
(3) Reef flat data excluded from 1993 data to make data bases comparable.
(4) 60-foot data excluded from 1993 data to make data bases comparable.

Appendix A

FEBRUARY 1993 CORAL REEF FIELD SURVEYS

CORAL REEF TRANSECT ANALYSES
FIELD SURVEYS CONDUCTED FEBRUARY 7-13, 1993
BY CH2M HILL
[VIDEO INTERPRETATIONS BY TROY BUCKLEY]

The following descriptions of each transect indicate the estimated percent areal coverage (usually in parentheses) for distinguishable biota. The locations of the reef transects in Pago Pago Harbor are shown in Figure 1-2 in this report.

INNER HARBOR, STATION S-1

Single continuous dive video transect from 20- to 50-foot depth, starting from a remnant coral head and proceeding downslope into the harbor basin. In this area, coral rubble, remnant semi-foliaceous coral structures and refuse are covered in terrigenous silt. The benthic habitat complexity and amount of refuse both decrease with increasing depth. A silt flat below the rubble and silt slope is perforated with burrows and appears to be frequently disturbed or silted. Overall, benthic cover is silt (30%), silt and rubble (50%), silt on dead coral formations (10%) and silt on refuse (10%). Refuse consists mostly of beverage cans and bottles and a tire. No fish were identified in this transect.

INNER HARBOR, STATION S-2

Single continuous dive video transect from 15- to 50-foot depth, down remnant coral slope to silt basin seabed. This transect is almost entirely silt covered. Overall, benthic cover is dominated by silt (80%), with some silt covered rubble (10%) and silt covered refuse (10%). Sponges are present but rare.

INNER HARBOR, STATION S-3

Single continuous dive video transect from 10- to 65-foot depths. The habitats along this transect are variable with flat silt and rubble areas near shore, large (dead) coral formations, and a steep slope down into the harbor basin. Near shore, a few sponges (<5%) are present, but silt covers almost all the hard substrates of coral rubble and refuse which includes corrugated roofing, bottles, cans and cables. A large remnant coral formation (probably *Lobophyllia*, *Porites* and *Diploastrea heliopora*) - with sponges (<5%) and coralline algae (<5%) encrusting the sides and under-surfaces - and a fallen cement piling mark the transition to the steeper slope where silted (95%) coral rubble and foliaceous coral formations (*Montipora*?, *Echinopora*?, *Turbinaria*?) with some encrusting sponges (<5%) give way to an increasingly silt covered bottom. Beyond this, the 100% silt bottom descends to the harbor basin. Most fish in the area are associated with the larger coral formations near the edge of the reef slope and include snappers (lutjanidae), a regal angelfish (*Pygoplites diacanthus* - pomacanthidae) and a turkeyfish (*Pterois volitans* - scorpaenidae).

INNER HARBOR, STATION IH-3, REEF FLAT TRANSECT

On the reef top the habitat is fairly complex with a variety of dead coral structures providing refuge habitat for the many fish in the area. On the reef margin, some live encrusting corals (perhaps <5%) and coralline algae (perhaps 20%) may be present but they were not seen. Further up on the reef flat, silt (50%) and algae (20%) are common while small patches of silty rubble (5%) and bottles (1%) are rare. The fish seen on the reef flat appear to be mostly surgeonfish (acanthuridae) and damselfish (pomacentridae) that utilize algae as a food source, although butterflyfish (chaetodontidae) were also seen.

INNER HARBOR, STATION IH-3, 25-FOOT TRANSECT

At a depth of 25 feet the coral rubble and remnant coral formations are almost entirely covered in silt (99%). Algae appears to be growing in the silt but is not consolidating it, and in areas where the sediment is deep there is evidence of a few burrowing organisms. Sponges (1%) are present on the limited hard substrate. A sea urchin and small unidentified fish were seen on the transect.

INNER HARBOR, STATION IH-3, 40-FOOT TRANSECT

At a depth of 40 feet the underlying substrate is primarily loosely consolidated plate-like rubble and silt with an area of remnant coral plates providing structure. Refuse is more prevalent here than other areas and includes clothing, boots and many bottles and cans. A layer of silt (98%) covers most of the bottom, but a few sponges (2%) occur throughout the transect.

INNER HARBOR, STATION IH-3, 60-FOOT TRANSECT

At a depth of 60 feet the substrate alternates between areas of dead foliaceous coral structures (probably *Echinopora*) and an almost entirely silt bottom. Refuse is plentiful at this depth as well. The silt (97%) has light and dark areas and is perforated with burrows and appears to be frequently disturbed. Sponges (3%) are most common on coral structures rising above the silt bottom, and a small (15 cm) organism resembling a bryozoan was observed on the silty bottom.

INNER HARBOR, STATION IH-4, 25-FOOT TRANSECT

At a depth of 25 feet, silt and sand cover most (90%) of the substrate. Silt and sand occur in narrow chutes and on a sill. Sand and coral rubble dominates, but dead (mostly *D. heliopora*) coral formations, although silt covered, lend some complexity to the habitat. Living benthic cover is dominated by the hard coral *D. heliopora* (5%) and some sponges (<5%), and soft coral (alcyonacea) (<1%), unidentified algae

(<1%) and probably coralline algae also occurs. Larger shields of *D. heliopora* occur above the transect, and several damselfish (pomacentridae) were seen.

INNER HARBOR, STATION IH-4, 40-FOOT TRANSECT

At a depth of 40 feet, the substrate alternates between fairly complex dead coral structures (mostly *D. heliopora*) and chutes of silt, sand and rubble. Silt and sand (20%), silt and rubble (50%), and silt on coral formations (25%) constitute the majority of the substrate. Living benthic cover includes the hard corals (5%) (*D. heliopora* (<5%) and encrusting *Montipora* (1%)) as well as sponges (<5%) and probably coralline algae. Small (50 to 100 cm) surviving patches of *D. heliopora* on larger shields are probably the result of heavy siltation that has killed most of the original colony. Several damselfish (pomacentridae) were seen in the area.

INNER HARBOR, STATION IH-4, 60-FOOT TRANSECT

At a depth of 60 feet, the slope is dominated by coral rubble interupted occasionally by dead *D. heliopora* shields and terracing plates (1 m). Silt and sand cover most of the hard substrate. Chutes of silt and sand (10%), silted rubble (80%) and silt on dead coral formations (9%) leave little hard substrate for the attachment of benthic organisms. Sponges (1%) occur, but coralline algae and other encrusting organisms which probably occur were not recognized.

INNER HARBOR, STATION IH-5, 20-FOOT TRANSECT

At a depth of 20 feet, coral rubble and a few dead coral formations dominate the substrate. Very little silt (5%) is present and a thin layer of algae (5%) coats some of the rubble. Coralline algae is prevalent (maybe 50%) but has not consolidated the rubble. Sponges (5%) and filamentous algae (1%) are conspicuous throughout the transect, and a large anemone (<5%) lives among some dead coral branches. Live coral cover (<5%) is sparse, with one Faviid colony (25 X 15 cm) (1%) occuring on the transect, but small encrusting colonies of *Porites* and *Montipora* may also be present. A large *D. heliopora* colony (5 m^2) was noted in shallower water during a previous (1991) survey. Damselfish (pomacentridae) including *Chrysiptera* spp., surgeonfish (*Acanthurus* spp. and *Ctenochaetus striatus* - acanthuridae) and wrasses (labridae) were seen.

INNER HARBOR, STATION IH-5, 35-FOOT TRANSECT

At a depth of 35 feet the habitat is dominated by terracing plates of dead coral colonies and unconsolidated coral rubble (some of it foliaceous) providing low relief and some small interstices. Overall, the substrate is shrouded by a thin layer of silt (95%). Free-standing and encrusting sponges (2%) and encrusting coralline algae (2%) covers the unsilted substrate. Live coral cover (1%) on the transect is limited to two *Fungia* individuals. A goatfish (mullidae), a bristle-toothed tang (*Ctenochaetus*

striatus - acanthuridae) and a butterflyfish (*Chaetodon* sp. - chaetodontidae) were seen on the transect.

INNER HARBOR, STATION IH-5, 50-FOOT TRANSECT

At a depth of 50 feet the transect extends over a sand and silt bottom (90%) covered partially by an algal film (5%) and perforated by a few (stomatopod shrimp? or marine worm?) burrows for the first 20 to 25 meters. The transect abruptly changes in the last 5 to 10 meters to mostly coral rubble that rises above the silt bottom. The coral rubble is covered entirely in silt that seems to be somewhat consolidated by hydroids (5%) and algae.

MIDDLE HARBOR, STATION MH-1, 25-FOOT TRANSECT

At a depth of 25 feet, the habitat is composed of coral formations of a variety of sizes with coral rubble and coarse sand (10%) accumulation in some of the low areas. The hard substrate is encrusted with coralline algae (43%), small sponges (7%) and sea squirts (ascidians) (5%). Tufts of filamentous algae (5%) were prevalent throughout the transect. Living coral (20%) colonies are represented by encrusting forms (5%) of *Montipora* and/or *Porites*, massive colonies (10%) of *Porites lobata* and/or *P. lutea*, and *D. heliopora* shields (5%) with much more *D. heliopora* above the transect. Small fish, including damselfish (pomacentridae), were present in the low habitat and the larger formations provide refuge for larger fish, including surgeonfish (acanthuridae) and wrasses (labridae).

MIDDLE HARBOR, STATION MH-1, 40-FOOT TRANSECT

At a depth of 40 feet, the habitat complexity decreases and is dominated by coral rubble of various sizes and some remnant massive formations. A layer of silt (25%) covers some of the hard substrate, especially in the lower areas with smaller rubble, and coralline algae (35%) consolidates the larger rubble and massive formations. Sponges (5%) occur throughout the transect but are more common among the larger rubble, and a cluster of (probably) zoanthids (1%) occur in the small, loose rubble. Living corals (<9%) include *D. heliopora* (5%), *Galaxea* (<1%), one *Fungia* (<1%), possibly *Montipora* (1%) and small, massive colonies (1%) that could not be identified. A spiny sea urchin, *Diadema* sp., and a few surgeonfish (acanthuridae) were observed on the transect.

MIDDLE HARBOR, STATION MH-1, 60-FOOT TRANSECT

At a depth of 60 feet, the habitat alternates between dead coral plates forming a terraced slope, semi-consolidated coral rubble (40 to 60 cm plates and massive forms) and gentler sloping areas with sand and/or small coral rubble. The silt cover (35%) decreases slightly along the transect. Coralline algae (30%) appears to be consolidating the coral rubble and sponges (5%) are frequently attached to the

underside of the substrate or are encrusting. A few small (15 to 40 cm) encrusting coral colonies occur (<5%) that may be *Montipora* and/or *Porites*.

MIDDLE HARBOR, STATION MH-2, 25-FOOT TRANSECT

At a depth of 25 feet, the rugose spur and groove habitat has ridges of complex coral formations interspersed with channels of sand and rubble (30%). The sand and silt in the channels is somewhat consolidated by an algal film. Silt on the hard substrate is minimal and is limited to horizontal surfaces near the channels. Sponges (5%) and coralline algae (20%) are abundant. The live coral cover (45%) is dominated by *D. heliopora* (30%) and several encrusting and plate-like colonies (15%) that may include one or more of the following genera; *Acropora*, *Montipora*, *Porites*, and "fire coral" *Millepora* (hydrocorallina). Small fish, including damselfish (pomacentridae) and juvenile surgeonfish (acanthuridae), were prevalent, and spiny sea urchins, *Diadema* spp., were observed.

MIDDLE HARBOR, STATION MH-2, 40-FOOT TRANSECT

At a depth of 40 feet, the coral formations are dominated by partially living *Lobophyllia* colonies that are less complex than the variety at 25 feet, but the channels of loose rubble and some sand (35%) are similar. Silt, sand and rubble on the hard substrate is minimal and is limited mostly to horizontal surfaces near the channels. Sponges (1%) and zoanthids (1%) occur, and coralline algae (20%) is abundant. The live coral cover (43%) is dominated by the partially living colonies of *Lobophyllia* (20%) and encrusting colonies (20%) of *Montipora* and possibly *Porites*. A *Fungia* (1%) and a colony of *Galaxea* (2%) also occur. Spiny sea urchins, *Diadema* spp., were visible under some structures, and a butterflyfish (*Chaetodon reticulatus* - chaetodontidae).

MIDDLE HARBOR, STATION MH-2, 60-FOOT TRANSECT

At a depth of 60 feet, the low habitat is almost entirely coral rubble, sand and silt with one disarticulating remnant *Lobophyllia* colony on the transect. Silt (30%) and silt covered rubble (35%) provide little solid substrate for the attachment of sponges (<5%), coralline algae (20%) and living corals (13%). Encrusting colonies (10%) of *Echinopora* and/or *Montipora* are the most abundant, but surviving *Lobophyllia* (1%) corallites, a *Fungia* (1%) and an unidentified digitate colony (1%) occur as well.

MIDDLE HARBOR, STATION MH-3, REEF FLAT TRANSECT

Along the reef margin, live coral (45%) is represented by encrusting *Montipora* (15%) and *Porites* (20%) colonies and *Pocillopora* (5%) and *Acropora* (5%). Soft corals (alcyonacea) (5%) and coralline algae (50%) also occur. Fish at the reef margin include damselfish (pomacentridae) and surgeonfish (acanthuridae). On the reef flat,

live coral cover (10%) decreases and coralline algae (90%) increases with increasing distance from the reef margin.

On the inner reef flat, there are deeper channels where sand and silt occur (5%) and living corals (30%) are more common, including *Acropora* (10%), *Pocillopora* (10%) and other corals (10%). Coralline algae (65%) remains the dominant benthic cover in this area. Butterflyfish (chaetodontidae) were observed on this part of the reef.

MIDDLE HARBOR, STATION MH-3, 20-FOOT TRANSECT

At a depth of 20 feet, the habitat is dominated by large (1 to 7 m) shields of *D. heliopora* interrupted by low areas of silt and sand (25%), some with complex dead coral formations providing hard substrate above the sediment. Live coral cover (51%) is composed of *D. heliopora* (50%) and a small unidentified coral colony (1%) (possibly *Astreopora*). The remaining hard substrate is covered primarily by zoanthids (15%), but soft corals (alcyonacea) (5%), sponges (1%) and coralline algae (<5%) are also present. The large *D. heliopora* colony at the beginning of the transect is growing over a stand of long dead, staghorn *Acropora*. One silt channel has no coral outcroppings and is pock-marked with (stomatopod shrimp? or marine worm?) burrows. Fish observed on the transect include surgeonfish (acanthuridae), damselfish (pomacentridae) and bannerfish (*Heniochus* sp. - chaetodontidae).

MIDDLE HARBOR, STATION MH-3, 35-FOOT TRANSECT

At a depth of 35 feet, terrigenous silt (50%) that is easily resuspended covers the bottom, but some silt covered coral structures and plate rubble (25%) add some relief. Portions of the coral structures that are not blanketed by silt are covered primarily by zoanthids (10%), filamentous algae (<5%) and sponges (1%). Live coral cover (10%) consists of a large mound of *D. heliopora* with only patches of living corallites, an apparently healthy colony of the same species (9%), and young (20 cm) colony of (probably) *Lobophyllia* (1%). Two areas have no coral structures and are pock-marked with (stomatopod shrimp? or marine worm?) burrows.

MIDDLE HARBOR, STATION MH-4, REEF FLAT TRANSECT

On the reef margin, live coral cover (15%) is composed of several small *Pocillopora* colonies (7%) and occasionally large colonies of *Porites* (8%). A very large (10 m) colony of *D. heliopora* visually dominates the reef slope below the reef margin. Soft corals (alcyonacea) (15%) and coralline algae (70%) are the dominant benthic cover at the reef margin. Fish are very abundant and include wrasses (labridae), damselfish (pomacentridae), butterflyfish (chaetodontidae) and many juvenile surgeonfish (acanthuridae).

The habitat on the reef top is fairly complex with many crevices and holes penetrating the even surface. Coralline algae (90%) remains the dominant benthic cover on the reef flat from the reef margin to the inner reef. Further from the reef margin

encrusting *Montipora* (3%) and *Porites* (2%) contribute to the live coral cover (5%). In more protected areas, sponges (2%) and many blue starfish (*Linckia* sp.) can be found. The fish assemblage is similar to that on the reef margin, but there are fewer fish.

MIDDLE HARBOR, STATION MH-4, 25-FOOT TRANSECT

At a depth of 25 feet the habitat alternates between low coral formations and chutes of sand and small rubble (40%). Sponges (5%), zoanthids (15%) and soft corals (alcyonacea) (10%) are common on hard substrates, and coralline algae (10%) encrusts the available substrate. Live coral (20%) is dominated by *D. heliopora* (15%) colonies and unidentified encrusting colonies (5%). Many types of damselfish (pomacentridae) were seen on the transect, and a pair of bicolor angelfish (*Centropyge bicolor* - pomacanthidae) and four dartfish (*Ptereleotris* sp. - microdesmidae) were seen in the area.

MIDDLE HARBOR, STATION MH-4, 40-FOOT TRANSECT

At a depth of 40 feet the habitat has little complexity and is dominated by sand on low coral formations and rubble. Overall, sand and rubble (50%) dominates the substrate, but sponges (3%), soft corals (alcyonacea) (2%), coralline algae (5%) and zoanthids (10%) find purchase on the solid substrate. Live corals (30%) are dominated by *D. heliopora* (27%), but unidentified encrusting corals (3%) also occur. Fish seen on the transect include several types of damselfish (pomacentridae), a regal angelfish (*Pygoplites diacanthus* - pomacanthidae), a poison-fang blenny (*Meiacanthus atrodorsalis* - blenniidae) and wrasses (labridae).

MIDDLE HARBOR, STATION MH-4, 60-FOOT TRANSECT

At a depth of 60 feet, the featureless habitat is dominated by silt (32%), silt on rubble (25%) and silt on low, foliaceous coral formations (40%). The minimal solid substrate at this depth is occupied by sponges (2%) and zoanthids (1%). Fish were not identified on the transect.

MIDDLE HARBOR, STATION MH-5, 25-FOOT TRANSECT

At a depth of 25 feet the habitat is comprised of a variety of fairly complex living and dead coral formations, and small amounts of sand (5%) accumulate only on the larger horizontal surfaces. Coralline algae (60%) and sponges (5%) are common on the dead coral substrate, and a soft coral colony (alcyonacea) (3%) occurs at the beginning of the transect. Live coral (27%) is dominated by *D. heliopora* (20%) that extends well above and below the transect. Other corals include staghorn *Acropora* (2%) and unidentified encrusting corals (5%). A variety of fish occur on the transect including surgeonfish (acanthuridae), wrasses (labridae), damselfish (pomacentridae), puffers (tetraodontidae), regal angelfish (*Pygoplites diacanthus* - pomacanthidae), long-

nosed and other butterflyfish (*Forcipiger* sp. and *Chaetodon* sp., respectively - chaetodontidae) and the moorish idol (*Zanclus cornutus* - zanclidae).

MIDDLE HARBOR, STATION MH-5, 40-FOOT TRANSECT

At a depth of 40 feet the habitat is composed of fairly complex coral formations and overhangs on a slope to a near vertical wall. Silt and sand (25%) settle only in low areas and on flat surfaces while most of the exposed hard substrate is encrusted by coralline algae (30%), sponges (10%) and unidentified encrusting organisms (24%). The "pink lace coral" *Stylaster* (hydrocorallina) (1%) occurs on the underside of large overhangs toward the end of the transect. Live coral cover (10%) is sparse with the lower edge of the large *D. heliopora* (5%) colony occurring at the 25 foot transect extending to and ending at a depth of 40 feet. Unidentified encrusting corals (probably *Montipora*) (5%) are also present.

MIDDLE HARBOR, STATION MH-5, 60-FOOT TRANSECT

At a depth of 60 feet the transect crosses two distinct habitat types. The first half of the transect follows a sloping bottom predominantly covered by silt, sand and rubble, and the second half is an almost vertical, dead coral substrate with silt on all horzontal surfaces. Silt, sand and rubble (75%) occupy most of the bottom. Sponges (5%) are small in the first half of the transect probably because the substrate is less stable, but are numerous in the second half of the transect. The hard substrate is also encrusted by coralline algae (maybe 10%) and perhaps other encrusting organisms (maybe 9%). Live coral cover (1%) is limited to a (20 cm) colony of *D. heliopora* (1%) that appears to be dying from siltation. A wrasse (labridae) was noted on the transect.

MIDDLE HARBOR, STATION MH-6, 25-FOOT TRANSECT

At a depth of 25 feet the habitat alternates between nearly vertical but complex substrate with small caves and slopes of silt, sand and rubble (50%). Sponges (10%) are common on the hard substrate and coralline alge (maybe 20%) also occurs. Encrusting corals (11%) are common throughout the transect and include *Montipora* (4%), *Echinopora* (2%), possibly *Acropora* (1%) and unidentified types (4%). Fish observed on the transect include lemonpeel angelfish (*Centropyge flavissimus* - pomacanthidae), longnose butterflyfish (*Forcipiger flavissimus* - chaetodontidae), damselfish (pomacentridae), wrasses (labridae) and surgeonfish (acanthuridae).

MIDDLE HARBOR, STATION MH-6, 40-FOOT TRANSECT

At a depth of 40 feet the transect begins in an area of moderate complexity where short coral structures rise 50 cm above a sand and rubble bottom then abruptly changes to larger coral structures which exclude the sand bottom. Overall, silt, sand and rubble (30%) are common on ledges and low areas, and sponges (5%) and

coralline algae (probably 5%) occurs on the hard substrate. *D. heliopora* (45%) dominates the live coral cover (60%), but *Montipora* (10%), *Echinopora* (3%), *Pocillopora* (<1%) and *Lobophyllia* (1%) also occur. Damselfish (pomacentridae) and a pufferfish (tetraodontidae) were noted on the transect.

MIDDLE HARBOR, STATION MH-6, 60-FOOT TRANSECT

At a depth of 60 feet the benthic cover is dominated by sand, silt and rubble (75%). Sponges (5%) occur on the hard substrate. As at the 40 foot depth, *D. heliopora* (15%) is the most abundant living coral (20%), and small colonies of encrusting and foliaceous *Montipora* (3%), *Lobophyllia* (1%) and probably a faviid (1%) are present. Surgeonfish (acanthuridae) and a small left-eyed flounder (bothidae) were seen on the transect.

MIDDLE HARBOR, STATION MH-7, 25-FOOT TRANSECT

At a depth of 25 feet the transect approximately follows along the reef margin of silt, sand and rubble (90%) that is interrupted by small areas of solid structure. Sponges (1%) and soft corals (alcyonacea) (5%) occur mostly where the substrate is solid. Live coral (4%) is sparse with theree small (25 cm) colonies of *D. heliopora* (3%), and possibly some very small, unidentified encrusting corals (1%). Damselfish (pomacentridae) also occur mostly near the solid substrate.

MIDDLE HARBOR, STATION MH-7, 40-FOOT TRANSECT

At a depth of 40 feet the silt and rubble slope is confined to narrow bands, but silt is prevalent on much of the remnant, foliaceous coral structures (possibly *Echinopora* or *Montipora*). Overall, silt, rubble and silt on solid substrate (75%) accounts for a majority of the benthic cover, but they decrease markedly in the last few meters of the transect. Sponges (2%) occur throughout the transect. Live corals (18%), including *D. heliopora* (especially in the last few meters of the transect) (15%), very small (5 cm) encrusting colonies (2%) of *Montipora* or *Echinopora* and a digitate *Porites* colony, are more common at this depth than at the 25 foot transect. Not on the transect, but in the area, two clownfish (*Amphiprion* sp. - pomacentridae) in an anemone, a bicolor cleaner wrasse (*Labroides bicolor* - labridae), juvenile surgeonfish (acanthuridae) and several species of damselfish (pomacentridae) were seen.

MIDDLE HARBOR, STATION MH-7, 60-FOOT TRANSECT

At a depth of 60 feet the habitat is generally complex with shelves and remnant foliaceous coral formations (possibly *Echinopora* or *Montipora*), but silt covers most (90%) of the benthos. Sponges (2%), a soft coral colony (alcyonacea) (1%), probably zoanthids (2%) and a sea fan (gorgonacea) (1%) occur. Live coral cover (4%) includes very small (5 cm) encrusting coral colonies (2%) (possibly *Echinopora* or *Montipora*) and a delicately branching colony (1%) (possibly *Seriatopora* or *Acropora*) occur, and a (1.5 m) shield of *D. heliopora* (1%) is just above the transect. A pair of

butterflyfish (*Chaetodon* sp. - chaetodontidae) and a bicolor cleaner wrasse (*Labroides bicolor* - labridae) were seen.

MIDDLE HARBOR, STATION MH-8, REEF FLAT TRANSECT

Near the reef margin there are small colonies of *Pocillopora* (3%) and other corals (2%). Coralline algae (75%) is common, and rubble and silt occur in low areas (15%).

Further onto the reef flat, coralline algae (75%) remains the dominant benthic cover, but *Pocillopora* (5%), *Porites* (5%) and unidentified encrusting corals (5%) contribute to the live coral cover (15%) that is fringing some of the lower areas where coral rubble (5%) accumulates. Fish are fairly abundant on the reef flat and include wrasses (labridae), damselfish (pomacentridae), red finned butterflyfish (*Chaetodon trifasciatus* - chaetodontidae) and snappers (lutjanidae). The reef flat ends abruptly at a long inactive borrow pit where the water deepens and the substrate is mostly coral rubble and sand.

MIDDLE HARBOR, STATION MH-8, 25-FOOT TRANSECT

At a depth of 25 feet the remnant coral substrate (composed mostly of foliaceous and branching structures - likely *Echinopora* or *Montipora* and *Acropora irregularis*, respectively) are interspersed with some areas of loose silt and rubble. Overall, silt and rubble (20%) are not prevalent, sponges (5%) are common and coralline algae (70%) probably encrusts most silt-free surfaces. Algae (1%) occur in turf and bubble varieties along the transect, and "fire coral" *Millepora* (hydrocorallina) (1%) forms small lattice colonies. Live coral (3%) is limited to a single *Fungia* (1%), but many small encrusting corals (maybe 2%) were probably not detected. Fish observed in the area include damselfish (pomacentridae), surgeonfish (acanthuridae), wrasses (labridae) and snapper (lutjanidae).

MIDDLE HARBOR, STATION MH-8, 40-FOOT TRANSECT

At a depth of 40 feet the habitat is dominated by rubble, sand and silt (75%), but some foliaceous and plate structures occur. Sponges (5%) are common and coralline algae (10%) probably encrusts the silt-free substrate. Living coral (10%) is limited to *D. heliopora* (5%) patches, a single *Herpolitha* (1%) and perhaps some unidentified encrusting corals (4%). A few bottles and cans occur on the transect as well as a 55 gallon drum. Fish observed in the area include damselfish (pomacentridae), surgeonfish (acanthuridae) and a pipefish (syngnathidae).

MIDDLE HARBOR, STATION MH-8, 60-FOOT TRANSECT

At a depth of 60 feet the habitat is dominated by foliaceous structures, but a layer of silt (90%) covers most of the hard substrate. Sponges (3%) are almost as common as

at the shallower depths, but coralline algae (2%) is probably rare. Live coral (5%) is limited to a single faviid colony (2%), some encrusting *Porites* (1%) and possible some unidentified encrusting corals (2%). A small starfish, a regal angelfish (*Pygoplites diacanthus* - pomacanthidae) and about 200 newly hatched fish larvae were seen on the transect.

OUTER HARBOR, STATION OH-1, 25-FOOT TRANSECT

At a depth of 25 feet, the reef face is nearly vertical with some caves and crevices of a variety of sizes. There is very little silt and sand (10%) and it only occupies protected horizontal surfaces. Sponges (10%) and coralline algae (50%) are prevalent and the "pink lace coral" *Stylaster* (hydrocorallina) (3%) is common on cave ceilings and the underside of large overhangs. Scleractinian corals (27%) are mostly encrusting colonies (20%) of *Montipora* and possibly some *Porites*, but a colony (90 cm) of *D. heliopora* (5%) and a small (10 cm) colony each of *Lobopyllia* (1%) and faviidae (1%) occur as well. A lemonpeel angelfish (*Centropyge flabissinus* - pomacanthidae), a pair of butterflyfish (*Chaetodon* sp. - chaetodontidae) and over a hundred damselfish (pomacentridae) were on the transect.

OUTER HARBOR, STATION OH-1, 40-FOOT TRANSECT

At a depth of 40 feet, the reef face is nearly vertical with many overhanging ledges and caves. Sand and silt (35%) are more common at this depth and it seems to be somewhat consolidated by algae and hydroids. Coralline algae (45%) is common, and sponges (10%) are most common under the ledges where the "pink lace coral" *Stylaster* (hydrocorallina) (3%) also occurs. The low coral cover (7%) at this depth is expected due to the reduced light levels under the ledges that overhang most of the transect, however, encrusting colonies (5%) of *Montipora* (and possibly *Porites* or *Acropora*) and *Galaxea* (2%) occur. A moorish idol (*Zanclus cornutus* - zanclidae) and a butterflyfish (*Chaetodon* sp. - chaetodontidae) occurred on the transect.

OUTER HARBOR, STATION OH-1, 60-FOOT TRANSECT

At a depth of 60 feet, the transect occupies two broad types of topography. The first half of the transect appears to be a moraine at the base of the wall and the second half appears to be a continuation of the wall into deeper water. Overall, a mixture of terrigenous silt and reefal sand covers rubble (35%) and coral formations (40%) and very little of it is consolidated by hydroids and algae. Coralline algae (10%) encrusts the hard substrate where the silt is reduced and sponges (10%) are common especially under the ledges where the "pink-lace coral" *Stylaster* (hydrocorallina) (1%) also occurs. Some unidentified encrusting coral colonies (<5%) occur on the later part of the transect.

OUTER HARBOR, STATION OH-2, 25-FOOT TRANSECT

At a depth of 25 feet, the habitat is complex with a multiplicity of structures, shelves and holes, and silt (0%) is essentially nonexistant. Sponges (2%) occur mostly in the larger crevices and coralline algae (20%) covers some of hard substrate. Two types of soft corals (alcyonacea) (10%) are common on the later half of the transect. Scleractinian corals (68%) are plentiful and include large shields of *D. heliopora* (15%), encrusting *Montipora* (5%), encrusting and branching *Acropora* (10%), branching *Pocillopora* (1%), massive faviids (5%), *Lobophyllia* (3%), unidentified encrusting colonies (25%) (probably one or more of the following; *Montipora*, *Echinopora*, *Acropora*, or *Porites*), and unidentified small (20 cm) branching colonies (4%) (probably *Pocillopora* or *Acropora*). Fish noted on the transect include many damselfish (pomacentridae), several surgeonfish (acanthuridae), filefish (monacanthidae), butterflyfish (*Chaetodon* sp. - chaetodontidae) and blennies (blenniidae).

OUTER HARBOR, STATION OH-2, 40-FOOT TRANSECT

At a depth of 40 feet, the habitat is less complex and follows a semi-regular alternating pattern of low coral formations and higher areas with more complexity frequently consisting of shelves terracing on the slope. Silt (0%) is not noticably present. Sponges (5%), coralline algae (20%) and small (15 to 50 cm) colonies of soft corals (alcyonacea) (15%) are common throughout the transect. Scleractinian corals (55%) are also plentiful at a depth of 40 feet and include a large shield of *D. heliopora* just off of the beginning of the transect. Encrusting corals on the transect include *Montipora* (5%), *Echinopora* (10%) and unidentified colonies (30%) that are probably one or more of the following; *Montipora*, *Echinopora*, *Acropora* and *Porites*. *Acropora* (5%) occurs in encrusting, delicate branching and rugged branching forms. Massive faviids (4%), *Porites* (*rus*?) (3%), a small (10 cm) *Lobophyllia* (1%), *Galaxea* (1%) and an unidentified digitate colony (1%) (probably *Pocillopora* or *Acropora*) contribute to the live coral cover as well.

OUTER HARBOR, STATION OH-2, 60-FOOT TRANSECT

At a depth of 60 feet the habitat is a little less complex than at shallower depths with some rubble accumulations in the lower areas. Silt and sand (20%) also occur in the lower areas. Sponges (2%), filamentous algae (1%) and soft coral (alcyonacea) (1%) occur on the transect but are not common. Coralline algae (15%) encrusts some of the hard substrate. The coral cover (61%) is fairly diverse and appears to be dominated by encrusting and foliaceous colonies of *Echinopora* (35%) of a variety of sizes (10 to 200 cm). Encrusting *Montipora* (13%) is common throughout the transect. Small (30 to 70 cm) colonies of *D. heliopora* (5%) are common on the last half of the transect, and some of them appear to be remnants of much larger colonies. On the first half of the transect, unidentified small (10 cm) digitate colonies (2%) are common (these may be *Stylophora* or *Pocillopora*). Four *Fungia* (2%) and one *Herpolitha* (1%) rest on the bottom, and a colony each of *Galaxaea* (1%),

Acropora (1%) and faviidae (or *Astreopora*?) (1%) occur. Surgeonfish (acanthuridae) were seen on the transect.

OUTER HARBOR, STATION OH-3, 25-FOOT TRANSECT

At a depth of 25 feet the habitat is complex with a variety of interstitial spaces between coral formations, but it is interupted by narrow bands of low complexity where sand and rubble accumulate. Overall, the sand covers about 30% of the bottom with some of it on hard substrate, and the rubble (2%) is limited to low areas. Coralline algae (<1%), sponges (<1%) and soft corals (alcyonacea) (2%) are rare. Near the end of the transect, dense stands of calcareous, bush-like structures (10%) occur that may be tubes of colonial polychaete worms (like *filograma implexa*) or a calcareous red algae. The coral cover (56%) on the transect is dominated by *Porites* (50%) (including *P. rus*, *P. lobata* or *lutea*, and an unidentified digitate type that is probably a species of *Porites*), but branching *Acropora* (5%) and *Pocillopora* (<1%) also occur. Farmerfish (*Stegastes* sp. - pomacentridae) have territories among the branches of *Acropora*.

OUTER HARBOR, STATION OH-3, 40-FOOT TRANSECT

At a depth of 40 feet the bottom is mostly sand and silt (42%) with silt-free coral formations rising above it that are partially encrusted with coralline algae (20%) and sponges (1%). As in the shallower transect, the end is dominated by dense stands of calcareous, bush-like structures (20%) that may be tubes of colonial polychaete worms (like *filograma implexa*) or a calcareous red algae. Live coral (17%) is encountered less frequently but is more diverse and includes *Porites* (10%) of the same types as the shallower transect, branching and table *Acropora* (5%), encrusting *Montipora* (1%) and massive Faviids (<1%). A pipefish (syngnathidae) was seen on the transect.

OUTER HARBOR, STATION OH-4, REEF FLAT TRANSECT

Along the reef margin, sturdy species of *Pocillopora* (50%) and *Acropora* (20%) are more common than other corals (10%), and soft coral (alcyonacea) (10%) occurs below the surf zone. Fish occuring along the reef margin include damselfish (pomacentridae), surgeonfish (acanthuridae), wrasses (labridae) and butterflyfish (Chaetodontidae).

On the reef flat there is less live coral (10%) and coralline algae (80%) dominates the solid substrate and the large coral rubble that occurs in low pockets.

OUTER HARBOR, STATION OH-4, 25-FOOT TRANSECT

At a depth of 25 feet the reef front is vertical but complex with many caves and ledges. Silt (5%) has accumulated on protected shelves and in small protected caves.

Some of the hard substrate in this transect occurs in partial caves and under large overhangs and is encrusted by a variety of unidentified encrusting organisms (30%). Coralline algae (20%) is common, and sponges (5%), hydroids (5%) and the "pink-lace coral" *Stylaster* (hydrocorallina) (1%) also occur. Living scleractinian corals (34%) include encrusting *Montipora* (25%) and possibly *Echinopora* (5%), as well as small colonies of *Acropora* (1%), *Pocillopora* (1%) and *Porites* (2%). Wrasses (labridae), squirrelfish (holocentridae), surgeonfish (acanthuridae), several species of damselfish (pomacentridae) and reticulated butterflyfish (*Chaetodon reticulatus* - chaetodontidae) were observed on the transect.

OUTER HARBOR, STATION OH-4, 40-FOOT TRANSECT

At a depth of 40 feet the habitat is quite complex with large and small ledges at either end of the transect but sand and rubble (30%) dominate the middle third. Most of the hard substrate is encrusted with coralline algae (40%), sponges (10%), hydroids and unidentified organisms (5%), and the "pink-lace coral" *Stylaster* (hydrocorallina) (1%) occurs on the underside of larger ledges. Live coral (15%) includes plate-like and encrusting *Echinopora* (5%), *D. heliopora* (5%), *Lobophyllia* (<1%) and unidentified digitate (2%) and encrusting colonies (2%).

OUTER HARBOR, STATION OH-4, 55-FOOT TRANSECT

At a depth of 55 feet the habitat ranges from complex coral structures to mostly sand bottom. The hard substrate is scattered over a mostly sand and rubble bottom (50%) with silt (25%) semi-consolidated by hydroids on about half of the hard substrate. Coralline algae (10%) and sponges (1%) encrust the available substrate. Live corals (8%) include delicately branching *Acropora* (1%), *Echinopora* (1%), *Porites rus* (1%) and unidentified branching and plate corals (5%). An encrusting colony of "fire coral" *Millepora* (hydrocorallina) (1%) which is often mistaken for a true coral also occurs. Damselfish (pomacentridae) were seen on the transect.

OUTER HARBOR, STATION OH-5, 25-FOOT TRANSECT

At a depth of 25 feet there is little complexity to the habitat which is dominated by branching *Acropora* rubble that is solidly consolidated by coralline algae (80%) and is relatively silt-free (<5%). The extensive consolidation of the rubble indicates that it has been relatively undisturbed for several years. Sponges (10%) are common among the rubble. Although live coral is not apparent in the video transect this type of habitat typically has many very small colonies of encrusting *Porites* and possibly *Montipora* that may cover as much as 5% of the hard substrate. Small surgeonfish (acanthuridae), dusky farmerfish (*Stegastes nigricans* - pomacentridae) and a cleaner wrasse (*Labroides dimidiatus* - labridae) were seen on the transect.

OUTER HARBOR, STATION OH-5, 40-FOOT TRANSECT

At a depth of 40 feet the habitat is of low complexity with consolidated coral rubble dominated by broken branches of *Acropora* similar to the shallower transect but with a large overhang at the end. The rubble is semi-consolidated by coralline algae (80%) and sponges (5%), and is generally free of silt (<5%). Calcareous, bush-like structures (2%) that may be a calcareous red algae. Living coral colonies (7%) are mostly small (<20 cm) encrusting or plate forms of *Montipora* (1%), *Acropora* (1%) and unidentified types (2%); although a digitate colony of (possibly) *Porites* (1%) and four *Fungia* (2%) corallites also occur.

OUTER HARBOR, STATION OH-5, 60-FOOT TRANSECT

At a depth of 60 feet the mostly silt and sand (70%) slope is covered with coral rubble that increases in amount and complexity along the transect, and a few shelves occur toward the end. Coralline algae (20%) encrusts most of the silt free hard surfaces, but sponges (<5%) also occur despite the loose (and relatively mobile) nature of the substrate. Live corals (4%) are limited to the family fungiidae which are not attached to the substrate and two genera *Fungia* (2%) and *Herpolitha* (2%) occur on the transect. Several types of damselfish (pomacentridae), surgeonfish (acanthuridae) and wrasses (labridae) were observed on the transect.

Appendix B

JANUARY 1991 CORAL REEF FIELD SURVEYS

Appendix B-1

RESULTS OF JANUARY 1991 CORAL REEF FIELD SURVEYS

Field surveys of the fringing coral reef in areas of Pago Pago Harbor were conducted January 14 through 18, 1991. These coral reef field surveys were designed to provide comparable records of the reef conditions around the entire harbor for use in an evaluation of reef-face habitat conditions in areas of the Inner, Middle, and Outer Pago Pago Harbor. These surveys were developed to provide a semi-quantitative summary of reef corals and other benthic species. Reef fish identifications were incidental to the habitat evaluation.

Marine biologist-divers conducted underwater video (8mm) transects of the reef fronts at 19 stations in Pago Pago Harbor (see Figure 1-2 in report). Three 20-meter video transects were recorded at each of 16 stations, and 20-meter video transects were recorded at the reef edge (15- to 20-foot depth), at 30- to 35-foot depths on the reef face, and at 50- to 60-foot depths on the reef face. For each transect, two passes along the established 20-meter line were recorded. Single continuous transects were conducted at three stations in the inner harbor (S-1, -2, and -3). Video records of the reef flat areas were also recorded at six stations. These video transect records were analyzed and summarized by a marine ecologist (Mr. T. Buckley) with several years of experience specifically in American Samoa. Estimates were developed of live coral coverage and specific benthic genera were identified as feasible. Results of the field surveys are summarized in Tables B-1, B-2, and B-3, and detailed descriptions of the transects records are provided in Appendix B-2 to this report.

The existing or remnant coral reef areas in the inner harbor are very limited as a result of shoreline filling and pier construction. The three transect stations in the western end of the inner harbor were established at known remnant coral reefs or coral heads. These three transect locations consisted of soft substrates and silt-covered remnant coral heads and coral rubble. No live coral or other hard-substrate organisms were present.

Three stations were surveyed in the transition area from the Inner to Middle Harbor (IH-3, -4, and -5), and sediments were observed to cover substantial areas of hard substrates at all depths. Station IH-4, located 200 feet east of the fuel dock and on the north face of the basalt outcrop at Goat Island Point, had less than 5 percent live coral at all depths, and mainly coraline algae and sponges were observed. Stations IH-3 and IH-5, located along the reef face between Trading Point (immediately east of cannery docks) and the rock jetty at Leloaloa, also had generally less than 5 percent live coral at all depths. The reef front at these two stations consisted of steep, silt-covered, rubble slopes.

Additional field survey results are available for the reef flat area between Trading Point and Leloaloa (AECOS 1990). AECOS, Inc., surveyed three transects across the reef flat in this region of the Inner Harbor in November 1990. An additional transect was conducted across the reef flat near CH2M HILL's station MH-2. Results of the three reef flat transects between Trading Point and Leloaloa, show very low

percentages of live coral cover (<2 percent). The live coral cover and benthic diversity were observed to increase on transects more distant to the east of Trading Point. Limited observations were made of the reef slopes (down to 20-foot depth), and these findings parallel the observations of the CH2M HILL surveys.

The Middle Harbor region of Pago Pago harbor extends roughly from Leloaloa to Aua Point on the northern and eastern shoreline, and from Goat Island Point to Tulutulu Point along the western shoreline. The Middle Harbor region includes areas of direct wave impacts along the northern shoreline, and two semi-enclosed embayments (off the villages of Utulei and Aua). Eight stations were located to represent the range of reef exposures around the middle harbor. Stations MH-1 and MH-2, were located along the northern shore that receives direct wave impacts. The transects conducted at these two stations, show markedly higher percentages (up to 50 Percent) of live coral and silt coverage is negligible. The number of coral genera observed increased substantially at the Middle Harbor stations, as compared to stations IH-3 and IH-5. These findings are also supported by the results of AECOS's reef flat and reef front survey transect No. 4, conducted near CH2M HILL's station MH-2.

The results of the reef surveys at MH-3 and MH-4, inside the semi-enclosed embayment between Leasi Point and Aua Point, show moderately diverse coral representation, and zoanthid colonies were the dominant benthic organism. Both MH-3 and MH-4 showed some siltation of flat surfaces, probably because of sediments released from the stream at Aua and from resuspended bottom sediments in the embayment.

Four stations (MH-5, -6, -7, and -8) were located along the western shoreline of the Middle Harbor. These reef areas have well established hard and soft coral with 10 to 60 percent live coral coverage. The two stations centered in the semi-enclosed embayment (MH-7 and MH-8) clearly show siltation resulting from Vailoa stream discharges and sediments resuspended in the excavated reef flat between the Pago Pago Yacht Club and the park.

The Outer Harbor region extends from Tulutulu Point to Niuloa Point on the western shoreline, and from Anasosopo Point to Breakers Point on the eastern shoreline. Five stations were located in the Outer Harbor: two along the eastern shoreline (OH-1 and OH-5) and three on the western shoreline (OH-2, -3, and -4). The steep reef face structure, percentages of live corals, silt coverage, and benthic diversity observed at stations OH-1 and OH-5 are similar to the reef face conditions at MH-5, located on the south face of Goat Island Point. Station OH-2 on a wave-exposed site south of Tulutulu Point had 10 to 35 percent live coral coverage and a similar diversity to the observed at MH-4. Stations OH-3 and OH-4, located in the semi-enclosed embayment off Fagaialu, had peak live coral coverages of 60 percent at 15- and 30-foot depths, respectively. The observed benthic diversity at Station OH-3 was comparable to the Middle Harbor stations and may be influenced by the siltation from Fagaialu Stream. Station OH-4, located in a wave protected area and swept by oceanic waters, yielded the highest diversity of hard corals.

These results of the field surveys of the fringing coral reef in Pago Pago Harbor indicate several clear trends in the reef habitat conditions. These coral reef field surveys were designed and conducted to allow comparisons of the reef conditions between areas of the Inner, Middle, and Outer Pago Pago Harbor. The survey results are summarized as follows:

- Approximately 5 percent of the fringing reef area of the Inner Harbor remains, and the remaining area is subject to sedimentation and light attenuation. The inner harbor seabed consists of silty muds and areas of silt-covered remnant coral structures. The remnant reef fronts surveyed in the western half of the inner harbor do not appear to sustain live hard or soft coral.

- The north-shore reef face between Trading Point and Leloaloa represents a transition zone from the heavily silted Inner Harbor to the Middle Harbor region. In the transition zone, less than 5 percent live hard coral was recorded.

- The Middle Harbor region includes a wide range of exposed and protected reef areas. Live coral coverages range from 1 to 60 percent, with an average of 20 percent for all depths. Reef areas in the middle harbor that are proximate to stream discharges at Aua and Utulei had reduced hard coral coverage and diversity.

- The outer harbor region also includes a range of exposed and protected reef areas. Live coral coverages were estimated to range from 5 to 60 percent, with an average of 19 percent for all depths.

- The live hard coral coverages and diversity at the Middle Harbor reef fronts are comparable to the Outer Harbor reef areas. Reef transect stations located near stream discharges in both the middle and outer harbor regions showed siltation effects, including reduced live hard coral coverage and diversity.

Table B-1. Results of January 1991 Coral Reef Surveys: Inner Harbor Transects

Station	S1	S2	S3	IH3			IH4			IH5	
Depth (ft)	15-40	15-60	10-65	20	35	60	20	35	60	15	35
Station Characteristics											
Percent Siltation, Sand, Sediment &	100	100	100	100	100	100	60	70	90	5	100
Slope Description	G	FS	G/S	FS	S	G	W	W	S	FS	FS
Aquatic Life (percent coverage)											
Sea Urchins											
Hydroids											
Sponges	0	0	0	0	<5	<5	10	5	<5	5	10
Zoanthids											
Coralline algae	0	0	0	0	0	0	20	20	30	<1	
Filamentous Algae										5	5
Fleshey algae											
Green Algae (Halimeda?)											
Soft Coral	0	0	0	0	0	0	<5				
Styllaster (non-scleractinian coral)											
Hard Coral (percent coverage)											
Diploastera								<5		<1	
Montipora									<5		
Faviid										<5	
Fungia											<1
Echinopora											
Porites											
Lobophyllia											
Goniastrea											
Acropora (?)											
Pocillopora											
Pavona											
Herpolitha											
Alveopora											
Astreopora											
Herpolitha											
Galaxea											
Millepora (fire coral - hydrozoan)											
Hydnophora											
Unidentified Encrusting Forms											
Unidentified Digitate Coral											
Total Percent Live Hard Coral	0	0	0	0	0	0	0	<5	<5	<6	<1
Total Number of Hard Coral Genera	0	0	0	0	0	0	0	1	1	2	2
Total Genera per Station	0	0	0	0			0			0	

(#) order of abundance
P = present (not quantified)
G = Gradual
FS = Fairly Steep
W = Wall
S = Steep
F = Flat
V = Very Steep
T = Terraced
S&G = Spur & Groove

Table B-2a. Results of January 1991 Coral Reef Surveys: Middle Harbor Transects

Station	MH1			MH2			MH3			MH4			
Depth (ft)	20	35	55	20	35	60	Flat	20	35	Flat	15	35	60
Station Characteristics													
Percent Siltation, Sand, Sediment &	0	< 1	<1	0	<1	60	0	?	90	30	40	30	80
Slope Description	G	FS	FS	G	FS	FS		G	F		T/S	T/S	G
Aquatic Life (percent coverage)													
Sea Urchins													
Hydroids													
Sponges	8	5	13	8		<1					<5	5	20
Zoanthids					P			35	<5		30	15	20
Coralline algae	70	60	65	70	50	60						5	
Filamentous Algae													
Fleshey algae													
Green Algae (Halimeda?)													
Soft Coral	18			15	5			<1			5	5	
Styllaster (non-scleractinian coral)													
Hard Coral (percent coverage)													
Diploastera					2				3	P	10	50	
Montipora		15	4		6				2				
Faviid			<1					2		P			
Fungia		< 1			7			3					
Echinopora		15	4		3	2							
Porites				<1	4		10			P			
Lobophyllia					1	1	<1			P			
Goniastrea					5			<1					
Acropora (?)							10			P			
Pocillopora							<1			P			
Pavona										P			
Herpolitha													
Alveopora													
Astreopora													
Herpolitha													
Galaxea													
Millepora (fire coral - hydrozoan)													
Hydnophora													
Unidentified Encrusting Forms	<1			<5									.
Unidentified Digitate Coral													
Total Percent Live Hard Coral	<1	>30	>8	<6	50	<10	>20	>5	5		10	50	0
Total Number of Hard Coral Genera	1	3	3	2	7	2	4	2	2		1	1	0
Total Genera per Station	5			8			9			7			

(#) order of abundance
P = present (not quantified)
G = Gradual
FS = Fairly Steep
W = Wall
S = Steep
F = Flat
V = Very Steep
T = Terraced
S&G = Spur & Groove

Table B-2b. Results of January 1991 Coral Reef Surveys: Middle Harbor Transects

Station	MH5				MH6			MH7				MH8			
Depth (ft)	Flat	20	35	55	20	35	60	Flat	20	35	60	Flat	20	35	60
Station Characteristics															
Percent Siltation, Sand, Sediment &		40	20	40	10	20	50		25	30	95	0	70	95	70
Slope Description		W	W	G	G-S	G	G		T/G	T/G	S		S	S	G
Aquatic Life (percent coverage)															
Sea Urchins									P						
Hydroids		40													
Sponges		13	20		5		5	<5	10	15	5		5	1	10
Zoanthids															
Coralline algae		30	20		30	50	50	35	30	50			20	5	10
Filamentous Algae															
Fleshey algae					<5										
Green Algae (Halimeda?)															
Soft Coral					15			30	10						
Styllaster (non-scleractinian coral)															
Hard Coral (percent coverage)															
Diploastera		15	15	10	15	20			10	10			8	P	
Montipora	P	5	5	P	P	5	<20		5	P	<5				
Faviid															
Fungia						P	<1						7		
Echinopora					P										
Porites	P				10				5	P		5?			
Lobophyllia				P	P	P									
Goniastrea															
Acropora (?)					P	P									
Pocillopora	P											25			
Pavona															
Herpolitha															
Alveopora															
Astreopora															
Herpolitha															
Galaxea															
Millepora (fire coral - hydrozoan)	P							P							
Hydnophora															P
Unidentified Encrusting Forms	<5		40					P							10
Unidentified Digitate Coral												P			
Total Percent Live Hard Coral	<5	20	60		30	30	20	<1	20	10	<5	30	15	<1	10
Total Number of Hard Coral Genera	5	2	>3		6	5	2	2	3	3	1	3	2	1	>2
Total Genera per Station	7				7			5				7			

(#) order of abundance
P = present (not quantified)
G = Gradual
FS = Fairly Steep
W = Wall
S = Steep
F = Flat
V = Very Steep
T = Terraced
S&G = Spur & Groove

Table B-3. Results of January 1991 Coral Reef Surveys: Outer Harbor Transects

Station	OH1			OH2		OH3			OH4			OH5	
Depth (ft)	20	35	60	15	35	Flat	15	30	15	30	50	30	50
Station Characteristics													
Percent Siltation, Sand, Sediment &	10	10	80	10	85	0	20	80	<5	0	60	5	100
Slope Description	W	W	FS	FS	S		G	F	T/W	S	G	W	FS
Aquatic Life (percent coverage)													
Sea Urchins												P	
Hydroids													
Sponges	10	15		<5					5	5	5	20	5
Zoanthids													
Coralline algae	60	70	10	30	5		40	25	85	25	10	60	35
Filamentous Algae													
Fleshey algae													
Green Algae (Halimeda?)			5										
Soft Coral	P									10	<5		
Styllaster (non-scleractinian coral)		P											
Hard Coral (percent coverage)													
Diploastera	P	P							P	P			
Montipora	P	P	<2.5	10	<10				P	P	P	P	P
Faviid				P	P					P	P		
Fungia				P						P			
Echinopora				15	P						15		P
Porites	P		<2.5	5		P	40	10		P		P	
Lobophyllia				P						P			
Goniastrea													
Acropora (?)						P	10	<5	P	P	P		P
Pocillopora				P		P	5		P	P		P	
Pavona				P					P	P			
Herpolitha					P								
Alveopora					P					P			P
Astreopora										P			
Herpolitha													
Galaxea											P	P	
Millepora (fire coral - hydrozoan)			5							P			
Hydnophora													
Unidentified Encrusting Forms							5	P		P			
Unidentified Digitate Coral													
Total Percent Live Hard Coral	10	<5	<10	35	10		60	15	10	60	5	10	5
Total Number of Hard Coral Genera	3	2	3	8	5		>4	>3	5	13	20	4	4
Total Genera per Station	4			10		4			15			7	

(#) order of abundance
P = present (not quantified)
G = Gradual
FS = Fairly Steep
W = Wall
S = Steep
F = Flat
V = Very Steep
T = Terraced
S&G = Spur & Groove

Appendix B-2

CORAL REEF TRANSECT ANALYSES FIELD SURVEYS CONDUCTED WEEK OF JANUARY 14-18, 1991 BY CH2M HILL [VIDEO INTERPRETATIONS BY TROY BUCKLEY]

INNER HARBOR, STATION S1

Dive video transect from 15- to 40-foot depth, starting on a remnant coral head and proceeding down to bottom.

In this area, coral rubble is present on shallow areas and decreases in size with increasing depth. The silt flat below the rubble and silt slope is perforated with burrows, but has no algal coat indicating frequent disturbance or siltation. The substrate is nearly void of any structural complexity and the few fishes seen were associated with a coral block (70 × 50 × 40 cm) (several small fish), another coral block with a substantial cave under it (one porcupinefish (diodontidae)—*Diodon hystrix*), and the mooring buoy anchor (several bannerfish (chaetodontidae)—*Heniochus* sp.). Overall, benthic cover is by silt (30%), silt and rubble (60%), silt on coral formations (10%), and silt on garbage (10%). Garbage consists of cans, bottles, a tire, and other refuse.

INNER HARBOR, STATION S2

Dive video transect from 15- to 60-foot depth, down remnant coral rubble slope to soft seabed.

Similarly, this area also has small coral formations and larger rubble in shallower water and the rubble decreases in size with depth. The flat silt bottom has very few burrows and a dark algal film. The burrows end a few meters from the rubble and silt slope, and the flat silt bottom is bare. Overall, benthic cover is dominated by silt (70%), with some silt and rubble (20%), silt on coral formations (5%) and silt on garbage (10%). Garbage consists of bottles, cans, plastic bags, rope, and other refuse.

INNER HARBOR, STATION S3

Dive video transect from 10- to 60-foot depth.

This area has a variable topography with flat silt and rubble areas near shore, large coral formations, and a steep slope down into the harbor basin. Near shore, the incidence of trash (20%) is very high and includes corrugated roofing, bottles, cans, oil drums, cables, and a cement column. Silt and rubble cover (20%) dominates the shallow areas with the trash. Large coral formations (15%; probably *Lobophyllia*, *Porites* and *Diploastrea*) mark the edge of the slope that is covered by increasing

amounts of silt and rubble with increasing depth. Where the slope levels off, silt (20%) with burrows dominates the cover and is then displaced by large plates (5%) of foliaceous, petal-like forms (*Montipora*?, *Echinopora*?, *Turbinaria*?) covered in silt. Beyond this, the 100% silt bottom descends to the harbor basin. Sponges (less than 5%) and coralline algae (5%) are present on shallower coral formations and larger rubble. Most fishes in the area are associated with the larger coral formations near the edge of the reef slope and include damselfish (pomacentridae), wrasses (labridae), surgeonfish (acanthuridae), bannerfish, and butterflyfish (chaetodontidae)—*Heniochus* sp. and *Chaetodon* sp.—and several others.

INNER HARBOR, STATION IH-3, 20-FT TRANSECT

At a depth of 25 feet, the gradual slope of the reef front breaks off into the steeper reef slope. This transect is below a large, massive (dead) *Porites* formation, but on the transect there are only a few short formations. The substrate is dominated by silt on rubble (75%), silt pockets (15%), and silt on formations (10%). Cover of live macro-organisms is almost 0%. Surgeon fish (ancanthuridae) and butterflyfish (chaetodontidae)—*Chaetodon* sp.—were present in the area.

INNER HARBOR, STATION IH-3, 35-FT TRANSECT

At a depth of 35 feet, the reef slope decreases in steepness, and maintains rather low complexity. Rubble (75%) dominates the substrate and consists mostly of broken branching and thin plate forms. Intact coral formations (20%), plates with vertical fingers (probably *Montipora* or *Porites*), and small shelves are less abundant. Beverage cans and other garbage (5%) are scattered on the bottom. Nearly all the substrate is coated with a layer of silt consolidated by hydroids or algae (100%). Sponges (less than 5%) are rare along the transect. The butterflyfish and bannerfish (chaetodontidae)—*Chaetodon* sp. and *Heniochus* sp.—were seen.

INNER HARBOR, STATION IH-3, 60-FT TRANSECT

At a depth of 60 feet, the slope decreases and is covered by dark silt (25%), coral rubble and silt (10%), and mostly plate coral formations and silt (10%). Then it gradually flattens into the silt bottom (50%) with shrimp burrows and algae (diatoms?) growing on the undisturbed surfaces. The coating of silt with hydroids or algae covers most hard surfaces and encrusting sponges are rare (less than 5%). One automobile tire lie on the transect.

INNER HARBOR, STATION IH-4, 20-FT TRANSECT

At a depth of 20 feet, the slope is fairly steep with a variety of habitat types including caves, ledges, coral formations and a silt moraine at the base of a wall. Silt (10%), silt and rubble (10%), and silt on coral formations (40%) is probably the result of construction. Coralline algae (20%) and sponges (10%) are common, and soft corals

also occur (less than 5%). Several fishes occur here including damselfish (pomacentridae), wrasses (labridae), surgeonfish (acanthuridae), the butterflyfish (chaetodontidae)—*Chaetodon citrinellis*, the angelfish (pomacanthidae)—*Centropyge bicolor*, and the moorish idol (zanclidae)—*Zanclus cornutus*.

INNER HARBOR, STATION IH-4, 35-FT TRANSECT

At a length of 35 feet, the slope is less steep but still with a variety of habitat types including ledges, coral formations and a silt moraine at the base of a wall. Silt (30%), silt and rubble (20%), and silt on coral formations (20%) are more pronounced here. Coralline algae (20%) and sponges (5%) encrust available substrate. There is live coral cover (5%) at this depth, but it is limited to small (60 to 70 cm) surviving patches of *Diploastrea* on larger shields. Death of the marginal *Diploastrea* polyps was probably the result of heavy siltation. About 20 bannerfish (chaetodontidae)—*Heniochus* sp., were seen here.

INNER HARBOR, STATION IH-4, 60-FT TRANSECT

At a depth of 60 feet, the slope becomes a wall in places with spurs of dead *Diploastrea* shields and shelving terraces (1 m) with silt accumulating mostly in the valleys and on horizontal surfaces. Steep silt slopes (10%), silt on rubble (20%), and silt on formations (40%) leave little hard substrate. Coralline algae (30%) probably encrusts most available substrate, though sponges (less than 5%) and encrusting *Montipora* (less than 5%) were noted. Several wrasses (labridae) and damselfish (pomacentridae) were in the area, as well as one moorish idol (zanclidae)—*Zanclus cornutus*.

INNER HARBOR, STATION IH-5, 15-FT TRANSECT

At a depth of 15 feet, the reef front breaks off into the steeper reef slope and is dominated by coral (mostly *Lobophyllia*) rubble substrate (95%) with a few short coral formations (5%). Very little silt is present (less than 5%) and a thin layer of algae coats some of the rubble. Coralline algae may be present on most of the rubble, but is difficult to distinguish. Sponges are common and cover about 5% of the substrate and a filamentous red algae (5%) is conspicuous throughout the transect. Live coral cover on the transect is less than 5% with one Faviid colony (15 cm) occurring on the transect, but a large *Diploastrea* colony (5 m^2) is present in shallower water. The jack (carangidae)—*Scomberoides lysan*—passed through the area.

INNER HARBOR, STATION IH-5, 35-FT TRANSECT

At a depth of 35 feet, the reef slope decreases in steepness closer to the flat silt bottom (with large burrows and mounds) and is dominated by larger coral rubble (branching and thick plates; 100%) with a thin silt film. Sponges (10%) and filamentous red algae (5%) are the only distinctive cover, and a small (5 cm) patch of

zoanthids occurred on the transect. Live coral cover on the transect is limited to one *Fungia*. Damselfish (pomacentridae) and the snapper (lutjanidae)—*Lutjanus fulvus*—are common, and one moray eel (muraenidae) was seen.

MIDDLE HARBOR, STATION MH-1, 20-FT TRANSECT

At a depth of 60 feet, several large boulders rise 1 to 2 meters over the short, lobate dead coral forms covering the gently sloping reef front. Structural complexity between the boulders is fair, but limited, and there is only a little silt. Most surfaces are encrusted with coralline algae (70%) and sponges (5 to 10%), and soft corals are prevalent (15 to 20%).

Living hard corals were not visible, however, some encrusting forms are probably present. Small fishes, including damselfish (pomacentridae), were present in the low habitat and the larger formations were refuge from the diver for larger fishes, including surgeonfish (acanthuridae) and the butterflyfishes and bannerfishes (chaetodontidae)—*Chaetodon vagabundus*, *C. unimaculatus*, and several *Heniochus acuminatus*.

MIDDLE HARBOR, STATION MH-1, 35-FT TRANSECT

At a depth of 35 feet, the slope steepens, and structural complexity is high. Massive and shelf dead coral formations combine to create caves and crevices of a variety of sizes. There is almost no silt except in some small channels between structures. Most surfaces are encrusted with coralline algae (50 to 70%), sponges (5%) and some live, encrusting corals. Overall, live coral cover is about 30%, with *Montipora* (100 cm) and *Echinopora* (30 and 70 cm) dominating, and two *Fungia* colonies were observed. Many fishes were observed at this depth including parrot fish (scaridae), wrasses (labridae), damsel fish (pomacentridae), and others.

MIDDLE HARBOR, STATION MH-1, 55-FT TRANSECT

At a depth of 55 feet, the slope is fairly steep and covered primarily by intact dead plates and branching forms of coral and coral rubble of the same composition. The complexity of the habitat is fairly high with several small caves, crevices and overhangs. The horizontal surfaces are covered with a little silt that appears to be mostly of reef origin, and sloping and vertical surfaces are encrusted with coralline algaes (60 to 70%) and sponges (10 to 15%). Some encrusting/plate coral colonies (probably *Montipora* or *Echinopora*) are scattered along the transect (5 to 10%), and a small (25 cm) massive colony of the family Faviidae occurs. Only small secretive fishes were seen.

corals also occur (5%). Live hard coral cover (10%) is entirely *Diploastrea* (100, 70, and 50 cm).

MIDDLE HARBOR, STATION MH-4, 35-FT TRANSECT

At a depth of 35 feet, the slope continues to terrace downward with silt (10%) and rubble and silt (20%) occurring between *Diploastrea* shields and under overhangs. Rubble and coral formations not covered with silt are encrusted with coralline algae and sponges (5%), and are covered with zoanthids (15%), *Protopalythoa* sp., and soft corals (5%). The live hard coral cover (50%) is monotypic *Diploastrea* shields (100 to 400 cm). The habitat has little complexity and is essentially a series of ledges and overhangs. A few damselfish (pomacentridae) are visible in the area.

MIDDLE HARBOR, STATION MH-4, 60-FT TRANSECT

At a depth of 60 feet, the topography is essentially flat or slightly sloped with some silt covered plates and shields of *Diploastrea* and rubble. Habitat complexity is limited. Sand and fine silt accumulation covers most of the bottom with sandflats (20%), silt on plate formations (40%), and silt on plate rubble (20%). Some of the coral formations, plates, and rubble are relatively silt free (20%) and are probably encrusted with sponges and coralline algae.

MIDDLE HARBOR, STATION MH-5, REEF FLAT

The reef flat on the south side of Goat Island Point is a base of consolidated coral pavement with some silt. Coral formations rise up to 70 cm from the pavement over 10% of the reef flat. Live coral cover (less than 5%) consists of small (less than 30 cm) digitate and encrusting colonies attached to or near the raised coral formations. Live corals include *Pocillopora*, *Porites*, *Montipora*, and the fire coral (hydrozoan), *Millepora*. Damselfish (pomacentridae), the blue starfish (*Linckia laevigata*) and a sea-cucumber (*Stichopus chloronotus*) occur on the reef flat.

MIDDLE HARBOR, STATION MH-5, 20-FT TRANSECT

At a depth of 20 feet, the wall on the south side of Goat Island Point is a mixture of caves, overhangs, small shelves and projections. There are few horizontal surfaces for silt to accumulate. A thin layer of silt seems to be held to many surfaces by an host of small algal or hydroid-like organisms (40%). The reef wall is also encrusted with coralline algae (30%) and sponges (10-15%). Live coral cover (20%) is dominated by *Diploastrea* (15%) with some encrusting forms including *Montipora* (5%). Damselfish (pomacentridae), several species of wrasses (labridae) and the common angelfish (pomacanthidae)—*Centropyge flavissimus*—inhabit the area.

MIDDLE HARBOR, STATION MH-5, 35-FT TRANSECT

At a depth of 35 feet, the wall has some ledges supporting more complex coral formations, some overhangs and some caves or "chimneys" that extend upward to the reef flat. Silt is not prevalent except where held onto surfaces by the small encrusting organisms (40%). Most surfaces are encrusted by coralline algae (20%), sponges (20%) and other organisms. Encrusting forms of live coral (probably *Montipora*) (5%) are most common in less shaded, vertical areas. Large shields of partially living *Diploastrea* contribute to a majority of the structure extending out from the wall, and the live *Diploastrea* is about 15% areal cover for the transect. Many damselfish (pomacentridae) were observed at this depth as well as wrasses (labridae), a lizardfish (synodontidae)—*Saurida gracilis*, the angelfish (pomacanthidae)—*Centropyge bicolor*, and the butterflyfish and bannerfish (chaetodontidae)—*Chaetodon lunula*, and *Heniochus* sp.

MIDDLE HARBOR, STATION MH-5, 55-FT TRANSECT

At a depth of 55 feet, large shields and small plates of dead *Diploastrea* create most of the horizontal structure near the base of the vertical wall. There is some silt present on horizontal plates and coral formations (30%), areas of sloping sediment (20%) and areas of sediment and rubble (40%). Live coral cover (10%) is predominately partially living *Diploastrea* shields, with some encrusting *Montipora*, and partially broken up *Lobophyllia* colonies. Squirrelfish (holocentridae) were observed under the overhanging plates and shields.

MIDDLE HARBOR, STATION MH-6, 20-FT TRANSECT

At a depth of 20 feet, there is a repeating spur and groove pattern as the reef "breaks" from a gradually sloping reef front to the steep reef slope. Silt (10%) accumulates in the grooves, sometimes with coral rubble or low plates (10%), and is fairly absent from the spurs of complex coral structures. Coralline algae (30%) encrusts most coral structures, and sponges (5%) and a fleshy alga (less than 5%) are common. Soft corals (less than 5%), are also conspicuous. Total hard coral cover (30%) is mostly provided by *Diploastrea* shields (40 and 250 cm) (15%) and by encrusting and small massive (10 to 30 cm) *Porites* (10%). Encrusting *Montipora*, plate *Echinopora* (50 cm), *Lobophyllia* (30 cm), and small branching *Acropora* (20 cm) are also present. Surgeonfish (acanthuridae) and the bannerfish (chaetodontidae)—*Heniochus* sp.—were among the fishes observed.

MIDDLE HARBOR, STATION MH-6, 35-FT TRANSECT

At a depth of 35 feet, the slope becomes more gradual and the pattern of coral formations bisected by sand channels continues. Silt accumulates alone (10%) or with coral rubble (10%) in the channels and in small overhung caves. Encrusting coralline algae (50%) covers most coral formations and sponges are uncommon here.

Diploastrea shields (40 to 200 cm; 20%) are the largest contributor to the 30% live coral cover, followed by encrusting *Montipora* (5%), and to a lesser extent by *Acropora* basal plates (20 and 40 cm), *Lobophyllia* (25 cm), *Fungia,* and *Herpolitha.*

MIDDLE HARBOR, STATION MH-6, 60-FT TRANSECT

At a depth of 60 feet, the base of the reef slope consists mostly of dead plates and formations rising up to 3 meters above sloping sand and silt moraines. Silt slope (5%) and heavy silt on plates (20%) is common. Unsilted surfaces are probably encrusted with coralline algae (50%) and sponges (5%). Live coral cover (20%) consists almost entirely of irregular raised and encrusting plates (probably *Montipora*) and a few *Fungia*. Fish in the area include parrotfish (scaridae), large damselfish (pomacentridae) and a snapper (lutjanidae) juvenile—*Macolor niger.*

MIDDLE HARBOR, STATION MH-7, REEF FLAT

The topography of the reef flat near the Yacht Club in Utulei is rugged with hills and valleys covered with branching *Acropora* rubble. The difference in elevation between the coral formations and the rubble valleys is about 2 m. The structure of this reef flat appears to have been influenced by the operation of the borrow pit just to the south. Soft corals (30%) are the most common cover besides coralline algae (30 to 40%), and sponges (less than 5%) are scattered over the reef. Encrusting corals are probably present, but were not detectable, and one colony of fire coral (hydrozoan)—*Millepora*—was observed. Damselfish (pomacentridae) and juvenile parrotfish (scaridae) were common, and some larger fishes, including wrasses (labridae), surgeonfish (acanthuridae) and triggerfish (balistidae), were seen around the larger formations having small caves.

MIDDLE HARBOR, STATION MH-7, 20-FT TRANSECT

At a depth of 20 feet, the topography resembles a repeating spur and groove pattern at the reef break with habitat complexity ranging from low to high. Silt (5%), silt and rubble (10%), and silt on formations (10%) are limited to lower areas between silt free rubble (10%) and coral formations (65%). Sponges are larger (15 to 20 cm) here than at other stations and cover about 10% of the substrate. Soft corals (10%) are common and coralline algae encrusts most available substrate (30%). Live hard coral cover is mostly *Diploastrea* (10%) colonies and probably encrusting forms of *Montipora* and/or *Porites* (10%). Spiny sea-urchins (diadematidae) and a squirrelfish (holocentridae) were seen under ledges.

MIDDLE HARBOR, STATION MH-7, 35-FT TRANSECT

At a depth of 35 feet, more pronounced spur and groove topography continues with a variety of complex habitat types. Silt (20%) is limited to the grooves where a little silt and rubble (5%) and silt on formations (less than 5%) also occurs. Coralline algae

(50%) and sponges (15%) are encrusting most of the hard substrate. Live coral cover is dominated by *Diploastrea* (10%) colonies (50 to 70 cm) and encrusting forms of *Montipora* and *Porites* are also present. Fishes sighted include several species of damselfish (pomacentridae), surgeonfish (acanthurids), parrotfish (scaridae), butterflyfish (chaetodontidae), snappers (lutjanidae)—*Lutjanus* spp., emperors (lethrinidae)—*Montaxis grandoculus*, and groupers (serranidae)—*Cephalopholis argus* and *Variola louti*.

MIDDLE HARBOR, STATION MH-7, 60-FT TRANSECT

At a depth of 60 feet, the reef slope becomes steep and periods of heavy siltation from Vailoa Stream remain as silt slopes (15%) and silt on coral formations (80%). The silt below the stream channel in the reef is dark brown and becomes lighter in color as the transect is followed away from the stream channel. Some structure still remains visible under the heavy silt layers. Much of the steep slope has plate formations extending outward (30 to 50 cm) and a few large overhangs. Sponges (5%) are fairly common and *Montipora* (less than 5%) coral colonies (30 cm) are present. Delicate branching corals were observed on the reef slope immediately above this depth.

MIDDLE HARBOR, STATION MH-8, REEF FLAT

The inner reef flat is of a fairly uniform depth with small coral formations creating an intricate network of crevices. There is almost no silt visible here and live coral cover (35%) consists of small (15 to 25 cm) *Pocillopora* (25%), massive *Porites*, an unidentified digitate coral, and probably encrusting types as well. Fishes occurring here include damselfish (pomacentridae), wrasses (labridae), and surgeonfish (acanthuridae). The outer reef flat has few live corals and graduates to more of a consolidated coral pavement with silt collecting depressions that increase in frequency toward the reef edge. The reef edge is a complex network of channels, holes and undercuts where the butterflyfish (chaetodontidae)—*Chaetodon citrinellus*—and the surgeonfish—*Acanthurus lineatus*—were seen. Beyond the reef edge there is mostly silt that slopes gradually away. Overall, this reef flat supports a large population of the sea-cucumber—*Stichopus chloronotus*—probably due in part to the slight nutrification from the sewer outfall.

MIDDLE HARBOR, STATION MH-8, 20-FT TRANSECT

At a depth of 20 feet, the reef is steeply sloping away from the shallow reef break. Complex habitat is sparse, except on a 7-m wide ridge that has large rubble, coral formations and (dead) *Diploastrea* shelves. Silt (10%), and hydroid or algae and silt on rubble (60%) and on coral formations (5%), limit the amount of hard substrate available for coralline algae (20%) and sponges (less than 5%). Live hard coral cover (15%) consists of a large (300 cm) *Diploastrea* colony and a *Fungia*. A spiny sea-urchin (diadematidae), a pipefish (syngnathidae) and an angelfish (pomacanthidae)—*Centropyge bicolor*, were among the fauna seen at this depth.

MIDDLE HARBOR, STATION MH-8, 35-FT TRANSECT

At a depth of 35 feet, the slope consists almost entirely of silt and rubble (85%) with some patches of silt (5%) and silted formations (5%). The rubble appears to include branching and delicately branching types and large plates (300 cm) of dead *Montipora* (?) occur on a ridge at one end of the transect. Coralline algae (5%), sponges (1%), garbage (1%), and one small (60 cm) colony of *Diploastrea*, also occur here. Damselfish (pomacentridae) were seen associated with the larger coral formations.

MIDDLE HARBOR, STATION MH-8, 60-FT TRANSECT

At a depth of 60 feet, the reef slopes gently and the topography resembles an alternating ridge and valley organization. The low areas are almost all silt (30%) and the ridges have nearly intact coral formations of frondiferous (thin, convoluted plates) and plate types. Though the coral formations are brittle, few are broken and there is little rubble (less than 5%), indicating that this area is protected from most destructive forces. Coral formations with silt (35%) are usually lower and closer to the silt channels. The remaining unsilted coral formations are encrusted by (probably) sponges (10%), coralline algae (10%) and encrusting corals (10%), though only one small (15 cm) encrusting colony of *Hydnophora* was identified. The angelfish (pomacantidae)—*Pygoplites diacanthus*—and the bannerfish (chaetodontidae)—*Heniochus* sp.—were seen noted.

OUTER HARBOR, STATION OH-1, 20-FT TRANSECT

At a depth of 20 feet, the very steep slope has few interesting characteristics. Silt (10%) has accumulated on horizontal surfaces and most of the hard substrate is encrusted with coralline algae (60%), sponges (10%), and hard corals (maybe 10%) including *Montipora* (15 to 40 cm), *Porites* (5 to 20 cm), and *Diploastrea* (40 cm). Soft coral also rarely occurs in the area. Several fishes were seen including damselfish (pomacentridae), wrasses (labridae), surgeonfish (acanthuridae), and the butterflyfish (chaetodontidae)—*Forcipiger flavissimus*.

OUTER HARBOR, STATION OH-1, 35-FT TRANSECT

At a depth of 35 feet, the slope becomes more like a wall with a series of ledges. Silt covers most horizontal surfaces (10%) and most of the hard substrate is encrusted with coralline algae (70%) and sponges (15%). The non-scleractinian, pink lace coral *Styllaster* grows on the underside of some ledges. Living hard corals (less than 5%) include *Montipora* (150 cm) and *Diploastrea* (70 cm).

OUTER HARBOR, STATION OH-1, 60-FT TRANSECT

At a depth of 60 feet, the slope is fairly steep with a variety of formations and ledges, but the steepness and complexity decrease where the transect is below a wall extending down from thirty feet. Overall, silt (20%), silt and rubble (50%), and silt on coral formations (10%) dominate the topography. Coralline algae (10%) encrusts the available substrate. A green algae, probably *Halimeda* sp., covers about 5% of the bottom, soft corals are rare, and a giant clam—*Tridacna maxima*—occurred on the transect. Encrusting forms of hard corals, *Montipora* and *Porites*, were present but accounted for little of the benthic coverage (less than 5%). The fire coral (hydrozoan) *Millepora* was more common (5%).

OUTER HARBOR, STATION OH-2, 15-FT TRANSECT

At a depth of 15 feet, the fairly steep slope is covered with complex coral formations. There is very little silt (less than 5%) and rubble (5%) is confined to one narrow band. All non-living substrate is encrusted with coralline algae (30%) and sponges (less than 5%). Soft corals occur in patches along this depth contributing about 25% to the live cover. Live hard coral coverage (35%) consists mostly of encrusting and plate forms (10 to 70 cm) of *Echinopora* (15%), *Montipora* (10%) and *Porites* (5%) with some *Pocillopora*, *Fungia*, *Lobophyllia*, *Pavona*, and Faviids (5%). Damselfish (pomacentridae), wrasses (labridae), parrotfish (scaridae), and surgeonfish (acanthuridae) were seen in the area.

OUTER HARBOR, STATION OH-2, 35-FT TRANSECT

At a depth of 35 feet, the slope is steep and is covered with silt (60%), and silt on (50 cm) shields (25%) with very little rubble. Encrusting by coralline algae is minimal (maybe 5%), and sponges and soft corals are scarce. Live coral cover is about 10%, with encrusting *Montipora* (10 to 50 cm) the most abundant. *Echinopora*, *Herpolitha*, *Alveopora*, and a Faviid colony were also identified.

OUTER HARBOR, STATION OH-3, REEF FLAT

The inner reef flat is of a fairly uniform depth with many small colonies and coral formations creating a fairly complex habitat. There is no silt, and live coral cover (35%) consists of *Pocillopora* (30%) with some *Acropora* and *Porites*. Damselfish (pomacentridae) are common among the coral colonies. Further out on the reef flat, the depth becomes more variable with about 1-m differences, and larger (100 cm), massive colonies of *Porites* (30%) dominate the small *Pocillopora* colonies (less than 5%). Several surgeonfish (acanthuridae) and wrasses (labridae) were seen in this area. Following an excurrent channel to the outer reef margin, the coral cover (60 to 80%) becomes monotypic *Porites* of a plate and digitate form. Fishes typically aggregate at these excurrent channels near the reef margin and many were seen here including damselfish, wrasses, surgeonfish and unicornfish (acanthuridae), and butterflyfish (chaetodontidae)—*Chaetodon unimaculatus*, *Chaetodon* spp.—and

bannerfish (chaetodontidae)—*Heniochus* sp. Beyond the reef edge, the reef front slopes steeply away with high coral cover dominated most visibly by staghorn *Acropora* and large, massive *Porites* colonies.

OUTER HARBOR, STATION OH-3, 15-FT

At a depth of 15 feet, the gentle slope is covered with branching and digitate coral colonies interspersed with narrow bands of silt and rubble. Coverage by silt (5%), silt and rubble (5%), and rubble alone (10%) is mostly limited to shallow depressions and channels. Coralline algae encrusts most hard surfaces that are not supporting live coral and other growths. Live coral cover is approximately 60%, composed mostly of digitate *Porites* (40%) and staghorn *Acropora* (10%) with some *Pocillopora* (less than 5%) and others. Small fishes, including damselfish (pomacentridae), wrasses (labridae), and surgeonfish (acanthuridae) were present.

OUTER HARBOR, STATION OH-3, 30-FT TRANSECT

At a depth of 30 feet, the nearly flat sand and silt bottom is at the base of the gentle, coral covered slope. The sand and silt (75%) is interrupted by garbage (5%) (tires, bottles and cans) and a few coral formations (20%). Most non-living hard surfaces are encrusted with coralline algae. Live coral cover is about 15% with mostly small (20 to 50 cm) and one large (200 cm) massive *Porites* (10%), small (20 to 40 cm) *Acropora* colonies (less than 5%) and others. *Porites* and *Acropora* are common in the area, and damselfish (pomacentridae) and the butterflyfishes and bannerfishes (chaetodontidae)—*Chaetodon* spp. and *Heniochus* sp.—were seen nearby. One lionfish (scorpaenidae)—*Pterois* sp.—occurred on the transect.

OUTER HARBOR, STATION OH-4, 15-FT TRANSECT

At a depth of 15 feet, the reef face is a wall partially under an overhang with greater structural complexity away from the overhang. Some reefal silt is evident at the base of the wall under the overhang but does not cover much area (less than 5%). Coralline algae (85%) encrusts most hard surfaces and appears to be very thick, which may be inhibiting coral settlement. Sponges (5%) and small (5 to 10 cm) soft corals (less than 5%) are present. Live coral cover is about 10% on the transect with *Pocillopora* being the most easily identified, and encrusting forms being the most common (*Acropora*, *Montipora*, *Pavona* (?)). A *Diploastrea* shield was noted near the transect. The butterflyfishes (chaetodontidae)—*Chaetodon reticulatus* and *Forcipiger flavissimus*—occurred as well as angelfish (pomacanthidae).

OUTER HARBOR, STATION OH-4, 30-FT TRANSECT

At a depth of 30 feet, the nearly 45° slope is covered with very complex habitat and some spur and groove topography. Silt is nearly absent with a trace in one depression. The hard substrate is encrusted by coralline algae (25%) and sponges (5%). Overall coverage by soft corals (10%) is dominated by a 3-m section of up to 80% cover. Live hard coral cover is about 60% consisting almost entirely of small (less than 30 cm) colonies of a variety of forms and genera, including *Porites*, *Acropora*, *Pocillopora*, *Montipora*, *Astreopora*, *Lobophyllia*, *Diploastrea*, *Pavona* (?), *Fungia*, *Herpolitha*, Faviids, the fire coral (hydrozoan) *Millepora*, and others. Fishes at this depth included damselfish (pomacentridae), wrasses (labridae), surgeonfish (acanthuridae) and several species of butterflyfishes and bannerfishes (chaetodontidae)—*Chaetodon* spp. and *Heniochus* sp..

OUTER HARBOR, STATION OH-4, 50-FT TRANSECT

At a depth of 50 feet, the base of the reef slope gradually flattens and is covered mostly by silt (45%), silt and rubble (5%) and silt covered formations (10%). Coral formations are encrusted by coralline algae (10%) and sponges (5%). Soft corals cover less than 5% of the substrate. Live hard coral cover (20%) is mostly large (50 to 80 cm) colonies of *Echinopora* (15%), and small encrusting and plate forms of several species including *Acropora* (possibly), *Montipora*, *Galaxea*, and Faviids. Damselfish (pomacentridae) and butterflyfish (chaetodontidae) were seen.

OUTER HARBOR, STATION OH-5, REEF FLAT

The reef flat appears to be consolidated coral formations encrusted with coralline algae and habitat complexity is low. One colony of fire coral (hydrozoan), *Millepora* (35 cm), was observed. The water was murky during a rain storm, so little of the reef flat was inspected.

OUTER HARBOR, STATION OH-5, 30-FT TRANSECT

At a depth of 30 feet, the slope is very steep to vertical wall with overhangs, caves and large crevices. There is very little silt (less than 5%), even on horizontal surfaces. Most surfaces are encrusted with coralline algae (60%) and sponges (20%), and soft corals are rare. Living hard corals (10%) are primarily encrusting forms including *Montipora* (50 to 70 cm) and *Porites*, but *Pocillopora* (20 cm) and *Galaxea* (10 and 15 cm) were also observed. A spiny sea-urchin (diadematidae) and many fishes were seen including squirrelfish (holocentridae), a sweeper (pempheridae), surgeonfish (acanthuridae), damselfish (pomacentridae), wrasses (labridae), snappers (lutjanidae) —*Lutjanus fulvus*, moorish idol (zanclidae)—*Zanclus cornutus*, a boxfish (ostraciidae), angelfish (pomacnathidae)—*Pygoplites diacanthus*, and the butterflyfishes (chaetodontidae)—*Forcipiger flavissimus*, *Chaetodon lunula*, *C. quadrimaculatus*, and *C. vagabundus*.

OUTER HARBOR, STATION OH-5, 50-FT TRANSECT

At a depth of 50 feet, the slope is fairly steep with few coral structures. Habitat complexity is low with silt (25%), silt and rubble (25%) and coral (plate) rubble (50%). Most hard surfaces are encrusted by coralline algae (35%) and sponges (5%). The silt contains small (5 mm) white disks that are probably calcified disks of a green algae, *Halimeda* sp., and the non-scleractinian, pink lace coral is present under ledges. Live coral cover (5%) is partially small encrusting *Montipora* (5 to 10 cm) and other genera, *Alveopora* (5 cm), *Echinopora* (20 to 30 cm), and basal plates of *Acropora* (10 to 40), including *A. hyacinthus*. Just beyond the transect, large (70 cm) plates of *Montipora* and *Echinopora* occur. Fishes observed at this depth include damselfish (pomacentridae) and a surgeonfish (acanthuridae)—*Zebrasoma* sp.

ADDENDUM

STUDY PLAN FOR FIRST CORAL REEF SURVEY WITH RESPONSE TO COMMENTS

AGENCY REVIEW DRAFT

JOINT CANNERY OUTFALL CORAL REEF SURVEY STUDY PLAN

for

StarKist Samoa, Inc.

and

VCS Samoa Packing Company

to comply with NPDES Permits

AS0000019

AS0000027

JANUARY 8, 19923

prepared by

CH2M HILL

AGENCY REVIEW DRAFT
January 8, 1993

JOINT CANNERY OUTFALL
CORAL REEF SURVEY STUDY PLAN

INTRODUCTION

This Coral Reef Survey Study Plan presents the plan for conducting field surveys of the existing coral reefs around Pago Pago Harbor. This study plan is required under the conditions of the United States Environmental Protection Agency (EPA) NPDES Permit No. AS0000019 for Star-Kist Samoa Inc. and NPDES Permit No. AS0000027 for VCS Samoa Packing Company. This document describes the objectives, approach, field methods, and data analysis procedures for the coral reef surveys.

Section I of the Star-Kist Samoa and Samoa Packing NPDES permits states the following concerning the Coral Reef Surveys:

> *"Within six months of the effective date of this NPDES permit, the permittee, in cooperation with {Samoa Packing Co.; Star-Kist Samoa}, shall submit a field study design for approval by ASEPA and EPA Region 9 to assess the potential impacts of the discharge on the nearby coral reef. The study shall include coral reef transects which shall conform to locations found on Figure 4 in the USE ATTAINABILITY AND SITE-SPECIFIC CRITERIA ANALYSES; PAGO PAGO HARBOR, AMERICAN SAMOA, FINAL REPORT (CH2M HILL, March 15, 1991). The intent of this annual survey is to detect significant differences, if any, from the database information found in the above-cited document. Videos shall be submitted to both the USEPA and ASEPA. Guidance for designing such surveys is provided in the Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters November 1982, EPA #430/0-82-010 (pages 70-71). In addition, the discharger should consult Ecological Impacts of Sewage Discharges on Coral Reef Communities, September 1983, EPA #430/9-83-010, for further information. The study shall be conducted within one year of the effective date of this permit and every two years thereafter."*

This study plan is being submitted to EPA to comply with the NPDES permit condition of Section I, and to provide for approval of this plan.

APPROACH

The NPDES permit states that coral reef surveys shall be conducted at all of the same sites surveyed during the 1991 Use Attainability Analysis (CH2M HILL, 1991), to detect significant differences, if any, from the 1991 baseline reef survey data. The wastewater discharge locations

for the canneries and receiving water conditions in the harbor have changed since the 1991 survey. In 1991, when the previous reef survey was conducted, the two canneries operated separate wastewater outfalls in the inner harbor area of Pago Pago Harbor. The 1991 surveys involved recording reef transects at multiple-depths along the reef fronts at 19 sites located around the entire circumference of Pago Pago Harbor. These 1991 coral reef field surveys were designed to provide comparable records of the reef conditions around the entire harbor for use in an evaluation of reef-face habitat conditions in areas of the inner, middle, and outer Pago Pago harbor. These surveys were designed to provide a semi-quantitative summary of reef corals and other benthic species, and reef fish identifications were incidental.

Presently, Star-Kist Samoa and Samoa Packing operate a joint wastewater outfall that extends over 7,000 feet west from the canneries to a deep-water site offshore of Anasosopo Point in the outer harbor. The outfall consists of a 16-inch HPDE pipe that terminates with a diffuser at a depth of 176 feet below MLLW. The diffuser is located north of To'asa Rock and approximately 500 feet west of the reef face near Anasosopo Point.

The approach and methodology for the coral reef survey has been designed to duplicate the 1991 reef video surveys that were conducted at each of the designated sites in Pago Pago Harbor, and to be consistent with available guidance provided in the Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters (USEPA, November, 1982). To meet the NPDES permit conditions, video transects will be recorded at multiple depths at each of the nineteen established reef transect sites around Pago Pago Harbor (Figure 1).

These coral reef field surveys will be conducted to provide video transect records of the reef conditions around Pago Pago Harbor that can be compared with the 1991 survey and with future surveys at the same locations. These surveys will be used to evaluate the condition of and changes to the reef-face habitat in areas of the inner, middle, and outer Pago Pago harbor. The surveys are limited to providing semi-quantitative data on the type, percent cover of live reef corals and other benthic species. Reef fish identifications will be incidental to the reef habitat evaluation. These video transect records will be analyzed and summarized by a qualified marine ecologist with knowledge of tropical reef taxonomy and several years of experience specifically in American Samoa. Estimates will be developed of live coral coverage and specific benthic genera identifications will be provided, as feasible from the video record. Field survey data will be presented in tabular formats in a coral reef survey report, and supporting data will be included in the report appendix. Copies of the video records will be provided to ASEPA and USEPA along with a report of the survey findings.

The first coral reef survey is presently scheduled for the first week of February 1993, after study plan approval by EPA. Subsequent surveys would take place in February 1995 and 1997.

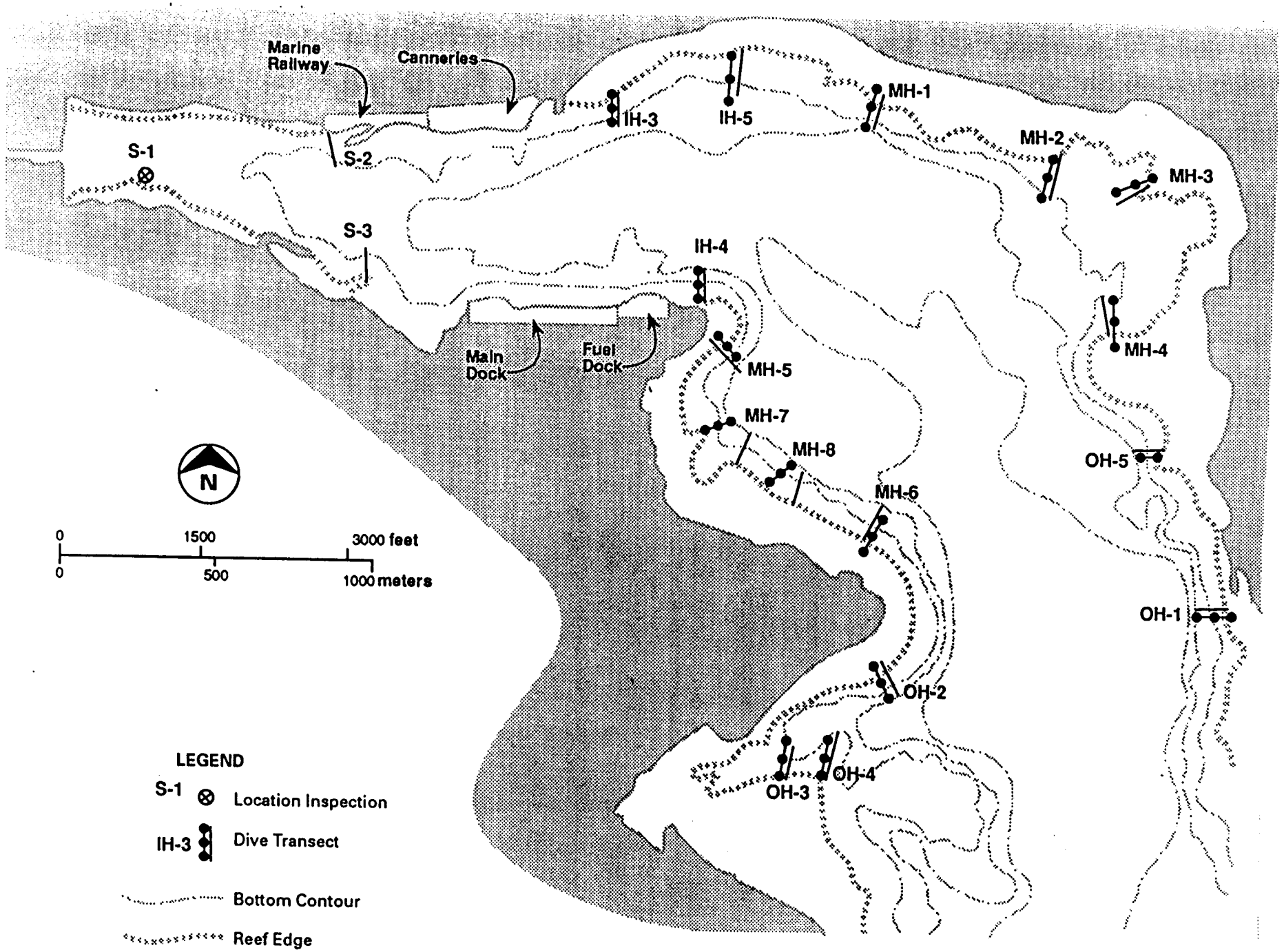

Figure 1

Coral Reef Transects in Pago Pago Harbor

STUDY METHODS

FIELD SURVEY METHODS

The following section describes the methods and equipment to be used for the coral reef surveys, including horizontal positioning at each reef site, sampling methods, and QA/QC procedures.

Field Equipment and Sampling Vessel

Field equipment requirements for the reef surveys are listed below in Table 1. A small work vessel will be used for the surveys. A three-person staff will be aboard to conduct the reef survey transects.

Table 1
Field Equipment for Coral Reef Surveys

Equipment Item	Purpose	Number of Units
Work Vessel	Field Sampling Platform	1
SCUBA diving equipment and tanks	Underwater surveys	3
ScubaPro Monitor II Dive Computer	Continuous dive logging for each diver's repetitive dives and surface intervals (safety equipment)	2
Sony 8mm Videocamera w/ underwater housing and lights	Underwater videotaping of reef transects	2
Sony 8mm Videotape player	Viewing and verification of videotape records	
Nikonos Camera	Underwater still photographs	1
30-meter transect line	Provide reference line for video transects	2
Transect Stakes	Establish start and end point for each transect	100
SeaKing Recording Fathometer	Record reef profile at each site	1
Motorola Mini-Ranger III System	Microwave positioning System with 3 shore-based transponders	1

Survey Sites and Field Positioning

Nineteen reef sites will be surveyed, and transects will be conducted at multiple depths at 16 of these sites. The three sites located in the western end of the inner harbor (S-1, S-2, and S-3) will only have a single transect conducted from the top to the base of the reef. The nineteen reef survey sites (Figure 1) will be located based on the descriptions in the 1991 reef survey logbook and photographs of the reef and shoreline at each site. A marker buoy will be set to mark each site. During the first reef survey in 1993, the horizontal position of each site will be recorded using a Motorola Mini-Ranger III electronic positioning system. The Mini-Ranger III will provide positioning accuracy of approximately ± 2 meters, to document each site in the harbor. A bathymetric profile of the reef front will also be made using a recording fathometer to document each site.

At each of the nineteen sites, transect marker stakes will be driven into the reef at the start and end of each transect. These stakes are designed to provide a long-term reference point for each transect line along the reef-face. In 1995 and 1997, if the transect marker stakes cannot be located by visual positioning, then the Mini-Ranger coordinates will be used to locate a site and a buoy will be deployed for divers to search for the stakes.

Reef Transect Methods

Marine biologist-divers will record underwater video transects on the reef fronts at 19 sites in Pago Pago Harbor (Figure 1). At 16 sites (IH-3, 4, 5, MH-1 through 8, and OH-1 through 5), video transects will be recorded along the reef face at three depths. The three sites located in the western end of the inner harbor (S-1, S-2, and S-3) are remnants of reefs with less than 5 percent live coral, and these sites will only have a single transect recorded from the reef flat down to the base of the reef face. Each video transect will be conducted parallel with the reef face (along a depth contour), and along a 30-meter fixed transect line on the reef. The depths for recording the video transects will include; the reef edge (15-20 foot depth), on the reef face (at 30-40 feet depths), and near the base of the reef face (at 55-65 feet depth). The reef front at some sites (e.g. MH-3) does not extend below 45 feet, and only two transects will be conducted at similar sites. Only single continuous transects from the reef top to base, will be recorded at the three inner harbor sites (S-1, -2, and -3). Video records of the reef flat areas will also be recorded at ~~six~~ five representative sites (IH-3, MH-3, MH-8, OH-3, and OH-5) to document reef flat conditions.

At each of the nineteen sites, two divers will descend to the three designated transect depths and hammer at 3-foot PVC marker stake into the reef to mark the transect start. These transect marker stakes are to be driven into the reef at the start and end of each transect line to provide a long-term reference point for each transect line along the reef-face. After each marker stake

has been established then the divers will be at the deepest transect and they will commence the transect surveys at that point. The second diver will payout the 30-meter transect line and hammer the end marker stake into the reef. The 30-meter transect line will have markings every 2.5 meters. The first diver will swim very slowly along the established 30-meter transect line with the video camera and record two passes on the line. The second diver will take still photographs at 5 meter intervals along the transect line using a 35mm camera. At the completion of the transect filming, the transect line will be picked up and moved to the next transect depth and the procedure will be repeated.

A field logbook will be maintained to include; the sampling times, descriptions of the site, transect depths, reef face structure and features, reef biota observations, and weather and sea conditions. The videotape will be viewed at the completion of each day in the field to ensure that the record is complete and to record the location of each trasect record on the video tape.

QUALITY ASSURANCE AND QUALITY CONTROL

The quality assurance and quality control objectives for the coral reef surveys are to record representative reef-front transects at each site and provide scientific interpretations and summaries of these reef transect videos that are of known and acceptable quality. The following requirements will be followed to meet the objectives.

- Provide verifiable photographic interpretations of the reef transect videos with QA procedures to estimate accuracy and error. Ten percent of all video transects will be reanalyzed without identification to estimate accuracy and error.

- Establish long-term transect markers and document survey site positions (within 2 meters) for repeat surveys.

- Provide field equipment redundancy (backup equipment).

- Develop a field operations and safety plan for conducting the reef surveys to summarize the schedule, survey procedures, field data recording, and safety procedures. This operations and safety plan is a key element of quality assurance and control activities.

- Test all dive and photographic equipment onsite prior to the beginning of the surveys and conduct daily equipment checks.

DATA ANALYSIS AND PRESENTATION

These surveys will be used to evaluate the condition of and changes to the reef-face habitat in areas of the inner, middle, and outer Pago Pago harbor. These surveys will be limited to providing semi-quantitative data on the type, percent cover of live reef corals and other benthic species. Reef fish identifications will be incidental to the reef habitat evaluation.

The videotape transect records will be analyzed and summarized by a qualified marine ecologist with tropical reef knowledge and several years of experience specifically in American Samoa. The videotape analysis involves repeated slow-frame viewing of the transect video to record estimates of live coral coverage and specific benthic genera. The percent of live coral will be estimated at 5 meter intervals along the transect line, for 2.5 meter segments. The still photographs will provide a secondary source for verification of estimates. Benthic genera identifications will be provided, as feasible from the video record. Field survey data and site positioning data will be summarized in tabular formats in a coral reef survey report, and supporting data will be included in the report appendix. Copies of the video records will be provided to ASEPA and USEPA along with a report of the survey findings.

RESPONSE TO COMMENTS ON CORAL REEF SURVEY STUDY PLAN

This addendum to the original study plan provides CH2M HILL's responses to comments on the Coral Reef Survey Study Plan provided by USEPA. Formal comments were not received separately from by other agencies. The comments were received shortly before the actual field work and a formal response to the comments was not prepared prior to conducting the first sampling for the sediment monitoring study. However, CH2M HILL reviewed and incorporated into the first sampling episode, where appropriate, the comments and concerns. A copy of the USEPA comment letter of 22 January 1993 is attached to the following responses. Responses to USEPA comments on the sediment monitoring study, and comments by other agencies on other required studies, were provided in a separate document.

Response to Comment 1. Macro invertebrates and macroalgae are included in the data sets.

Response to Comment 2. The coral reef surveys are intended to monitor long term trends. The water quality monitoring by ASEPA is also aimed at monitoring long term trends. There would be no correlation expected between coral reef observations and measured water quality parameters on any given day. We have no objection to coordination of ASEPA sampling with the coral reef surveys, but do not believe the surveys should be specifically scheduled to coincide with the water quality monitoring.

Response to Comment 3. This is a typographical error, there are only five representative sites planned for reef flat transects.

Response to Comment 4. The person doing the interpretation will not be doing the actual video taping. The person doing the interpretation is Mr. Troy Buckley, he is a Marine Ecologist with expertise and experience in coral reef ecology and has done previous video interpretations of records from Pago Pago Harbor. Mr. Buckley provided a similar analysis for the *Use Attainability and Site Specific Criteria Analysis* (CH2M HILL, 1991) referenced in the NPDES permit condition.

Response to Comment 5. It is intended that more detail concerning the method for analysis of the video tapes be described in the report, along with any particular problems and recommendations for future surveys. Tapes will be played on a high resolution television receiver. Distance markers along the transect line will be used to mark position. Freeze frame and repeated viewing will be employed, Additional reference to methods and results are described in the *Use Attainability and Site Specific Criteria Analysis* (CH2M HILL, 1991) referenced in the NPDES permit condition.

Response to Comment 6. The surveys will be done every two years. We believe a two year period is sufficient to monitor long term trends in the condition of the reef since changes are expected to be gradual. The markers can be reestablished, if necessary, prior to future surveys. There is no reason to re-establish them between surveys if they are lost.

Response to Comment 7. The following responses are provided for the four specific request in this comment:

[a] A Sony 8mm camera with a 35mm (wide angle) lens will be used.

[b] Swimming speed will be approximately 100 feet in 10 minutes (about 3 meters per minute or less than 0.2 feet/second).

[c] The camera distance from the bottom will be approximately 1 meter.

[d] We believe all other required information is provided in the study plan, in the report, or referenced (for example in the *Use Attainability and Site Specific Criteria Analysis* (CH2M HILL, 1991).

Response to Comment 8. The intent of the study is to monitor long term changes in the reef habitat as a whole in various locations in the harbor. In addition, we feel that the establishment of specific one meter square quadrants would be redundant since the records at the start and end of each transect line (at the markers) will serve the same purpose if small scale areas are of interest.

Response to Comment 9. The referenced documents were reviewed and information incorporated as appropriate.

Response to Comment 10. A separate sediment monitoring study is being conducted as another condition of the NPDES permits for the purpose indicated in the comment. Since the effluent plume will generally be trapped below depths greater than 60 feet, no direct influence of the effluent plume is expected in the sediments at transect locations.

Response to Comment 11. The final report includes sections functionally equivalent to those requested.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

January 22, 1993

Steven L. Costa
Project Manager
CH2M Hill
1111 Broadway
P.O. Box 12681
Oakland, CA 94604-2681

Re: Review of the Joint Cannery Outfall Sediment Monitoring and Coral Reef Draft Study Plans

Dear Steve:

We have reviewed the draft sediment monitoring and coral reef study plans submitted to us on January 6, 1993. Both studies are required by the canneries' NPDES permits. Generally both plans are acceptable, and address the objectives of the studies as outlined in the permits. Both studies appear to be well planned. We find that the use of the Mini-Ranger for locating sampling sites is an excellent idea.

However, we have the following comments and recommendations which we would appreciate being commented upon and/or addressed in the final plan:

Draft Sediment Monitoring Plan

1. Total Organic Carbon measurements are preferred over Total Volatile Solids (TVS) because it is a better indicator of sediment organic compounds.

2. Total grain size distribution measurements should not be optional as they are an important assessment of solids dispersal in the harbor (i.e., percent silt, clays, sands, etc.).

3. In addition to references mentioned in the plan, other reference documents should be consulted re: collection, storage, analyses, i.e, EPA's 301(h) QA/QC document (EPA 430/9-86-004) and the EPA/COE 1991 Evaluation of Dredged Materials Proposed for Ocean Disposal (EPA-503/8-91/001). If you do not have these documents, feel free to visit our office to review our copies.

4. Have sediment traps been considered? If not, why not? Sediment traps would enable one to determine deposition of new

material over time. Also, a van Veen sediment grab sampler is preferred over a Ponar sampler.

5. Will total and/or water soluble sulfides be measured? What methods will be used? (See 301(h) QA/QC document). Should ammonia also be measured since it is the form of nitrogen that is most readily utilized by phytoplankton and macroalage?

6. How will Eh be measured? (A copy of a suggested procedure is enclosed as Attachment 1.) At what depth will it be measured? If only one measurement will be taken we suggest it be at the 2 cm depth. However, a full vertical profile through the sediments is preferred.

7. Where will temperature and pH be measured? Will they be measured at the surface, 2 cm depth, and at other depths? Please explain the rationale and objectives for measuring pH, Eh and temperature at depth(s) chosen.

8. How will the sediment grab sampler and stainless steel bowls be cleaned between sampling events to minimize cross-contamination between stations?

9. Will only the surface sediments be photographed? If yes, why? We suggest that photographs also be taken of sediment cores as changes in color could then be correlated with other data re: Eh, particle size, hydrogen sulfide, etc.

10. We have no objection to the modification of the monitoring schedule proposed, i.e., having the first two sampling episodes during the first year of the study, six months apart. However, we recommend that the third sampling event occur 12 months after the second episode, versus 18 months as proposed in the study. We feel that the 18-month interval is too long after the second sampling event. Also, a 12-month interval would enable the sampling to take place during the same time as the first event. This should provide information to assist in determining the best season for the annual sampling in the future.

11. Compositing the sediment samples may greatly affect the hydrogen sulfide measurements. Perhaps separate discrete samples should be collected for hydrogen sulfide measurements before compositing.

12. We suggest that a minimum of 2 liters of sediment per station be collected and that excess sediment samples be archived in case there are problems with any of the measurements.

13. The final report on the study results submitted to USEPA and ASEPA should include the following: Introduction, Methods and

Materials, Results, Discussion and Recommendations, and Conclusions.

14. Table 2 on Sediment Chemical Analyses indicates standard methods numbers which are outdated. See 1989 edition of Standard Methods.

Draft Coral Reef Study Plan

The draft plan for the coral reef study is generally good. We especially find noteworthy the use of a Mini-Ranger for siting, use of permanent transects and the adequate number of stations to be surveyed, and the various depths at each station. Our review comments are as follows:

1. Benthic organisms included in the semi-quantitative data sets at each transect should be macroinvertebrates and macroalgae.

2. If possible, water quality sampling should be coordinated with the reef surveys so that any potential correlations between water quality and biological data can be noted. Water quality monitoring should be performed either on the same day or within a week of the coral reef surveys.

3. On page 5, end of the third paragraph, only five representative sites are specified where video records of reef flats will be taken. Where is the sixth representative site?

4. Will the marine ecologist who will be analyzing the videos also be involved in conducting the transects? Please provide a copy of his resume/experience in tropical marine waters.

5. Please describe in detail how the video transect records will be "analyzed and summarized" (see page 2 of the draft plan).

6. We recommend that all sites be visited at least once per year to ensure that the transect marker stakes are still present and/or whether any major changes to each site have occurred.

7. Please describe in detail the video equipment and methods to be used during the videotaping of each transet. This would include information describing:

   a. The camera(s) to be used and "line of resolution" per frame;

   b. Recommended swimming speed for each transect;

   c. Standardized distance from the bottom that will be used during videotaping and the taking of still pictures; and,

d. Any other revelant information.

8. In order to quantitatively document changes within and between the silts over time, we strongly recommend that at least one permanent square-meter quadrant be established along each transect line.

9. For additional guidance in modifying the design of the coral survey plans, please refer to the attached documents entitled: Effects of Sugar Mill Waste Discharge on Reef Coral Community Structure, Hamakua Coast, Island of Hawaii (Attachment 2) and Proposal for Long-Term Monitoring and Management Research on Coral Reefs (Attachment 3).

10. It might be worthwhile to investigate whether a chemical indicator exists in the cannery effluent (e.g., aluminum from the alum added to the wastewater treatment system) which can be measured in the sediment. This would assist in determining transport, dispersion, etc. of the effluent in the harbor.

11. The final report on the study results submitted to USEPA and ASEPA should include the following: Introduction, Methods and Materials, Results, Discussion and Recommendations, and Conclusions.

Also attached are the American Samoa Department of Marine and Wildlife Resources' (DMWR) comments on the sediment monitoring plan and the dye study plan (Attachment 4). We would appreciate your response (in writing) regarding our concerns raised above, and the comments provided by DMWR regarding the draft sediment monitoring plan and the dye study plan. Please call Pat Young at 415/744-1591 if you have any questions.

Sincerely,

James B. Branch

for Norman L. Lovelace, Chief
Office of Pacific Island and Native
American Programs (E-4)

Enclosures (4)

cc: Sheila Wiegman, American Samoa EPA